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READINGS IN GENERAL PSYCHOLOGY

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READINGS IN GENERAL PSYCHOLOGY

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PREFACE

We are publishing this volume in the belief that the student beginning the study of psychology can profitably read much more material than is commonly assigned him. It is hardly the purpose of a first course to train the student to such a point that he can read the technical articles of the psychological journals, but he should have enough practice to enable him to read with intelligence the more general literature of the subject, whatever its point of view. But the accomplishment of even this latter purpose is becoming increasingly difficult. Our elementary courses contain so many students that library assignments are in many cases all but impossible. In light of this fact, we feel that instructors will welcome a single volume which contains an ample and representative supply of reading materials.

Such a volume has an advantage over a library reserve shelf in that the students will not be discouraged by being unable to reach their assignments when and where they find it convenient to study. It has an advantage over a second textbook in that it contains more than another, often conflicting, system of description.

In those cases where the instructor is interested in presenting his own system, this volume will furnish reading materials which will be useful without coming into constant conflict with the lectures. While we do not believe that differences of opinion should be hidden from the student, we are convinced that constant conflict between instructor and text is very bad from a pedagogical standpoint.

We have chosen these readings for the beginning student, and we hope that few of them will be beyond his comprehension. Now and again terms appear in the readings which have not previously been defined. Usually where the meaning of such terms cannot be inferred from the context, we have defined them in footnotes. It is no disadvantage, however, if the student is occasionally forced to use a dictionary.

The exercises included with the readings are not, in most cases, questions the answers to which can be taken directly from the text. Rather, they are problems which the student should be in a position to attack when he has mastered a given reading or group of readings. In many cases these exercises are designed to bring out important points with which the readings do not happen to deal. In other cases they are designed to bring up problems which will hardly be solved by either instructor or student, but which nevertheless may profitably be discussed.

Where suitable materials could be found in the sources, we have used them. Where these sources were too technical, too long, or too saturated with dead issues, we have taken more suitable restatements. We have exercised considerable freedom in using certain excerpts which are not particularly representative of the writers from whom they are taken. While we have made slight changes in many of the selections, these changes are practically all of two kinds. First, sentences or words have been eliminated in order to avoid issues which could not be discussed at length, and which we did not feel could be handled justly in a very brief way. Second, sentences or words have been modified or eliminated in order to disconnect a selection from its original setting. In neither of these cases, we feel sure, have meanings been attributed to an author which he himself did not intend.

While we have arranged the contents of this volume along conservative lines, the readings can be taken up in almost any order. We have put side by side passages written from different points of view, and though we believe the student should get used to these differences and learn to see beyond them, there is no reason why the instructor should not emphasize certain facts and theories by a judicious choice from among these materials.

Needless to say, we are grateful to many writers and publishers for the privilege of quoting from their works. We must have done injustices to some by displaying in detached form their descriptions and opinions. Our only justification for this procedure lies in the very practical, pedagogical nature of our task.

We are indebted to Miss Frances Botkin, instructor in psychology in Smith College, and to Mr. Chester Darrow, assistant in psychology in the University of Chicago, for aid in the reading of proof and in the preparation of the Index.

E. S. R.
F. R.-R.

Chicago, Illinois
July, 1923

PREFACE TO THE REVISED EDITION

The present revision is mainly an enlargement of our earlier book. A few selections occurring in the first edition have been omitted, but where there are such omissions, new selections cover essentially the same ground and usually in greater detail. Thus, teachers who have become accustomed to the first edition will be able to adapt themselves to the new one with little inconvenience.

In revising this compilation of readings we have continued to keep in mind the needs of the undergraduate. We have made no effort to include selections in such a manner as to be fair in a historical sense to individual psychologists. What we have sought to be fair to is modern, scientific psychology. And we have gathered what have seemed to us to be clear and helpful introductions to many of the facts and issues of the subject. We have not tried to represent all of the up-to-date factions into which professors of psychology are prone to divide themselves. Since the professors, themselves, have little idea of which of the current "isms" will turn out to be important, how can the party platforms bring anything but headache to the undergraduate?

We wish to thank the authors and publishers who have permitted us to add to this edition quotations from their works. We would mention especially Professor John A. McGeoch for having prepared specifically for publication here a thorough account of experimental studies of memory, Professor Walter B. Cannon and D. Appleton and Company for allowing us to reprint a long selection from the new edition of *Bodily Changes in Pain, Hunger, Fear, and Rage*, and Dr. Mandel Sherman and Dr. Irene Case Sherman, as well as their publisher, W. W. Norton and Company, for allowing us to use two long selections from their book, *The Process of Human Behavior.*

E. S. R.
F. R.-R.

New Haven
February 28, 1929

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CHAPTER I

THE PROBLEMS OF PSYCHOLOGY

The subject-matter of a science consists in a more or less well-defined set of problems. For some of these there are solutions which are so satisfactory that they are generally accepted by trained and competent thinkers. For others there are tentative solutions, the merits of which are subjects of rigorous debates which call for the marshaling together of evidence from all possible sources. For still others there is little more than a statement of the problem. Even tentative solutions must wait for the dawn of a scientific morrow.

In order to obtain a grasp upon the science of psychology, then, it will be necessary for us to face, one by one, its more fundamental problems. Where the solutions to these problems warrant it, we must master them; where problems face us which are but tentatively solved, we must master the issues involved, and try to reach an understanding of why these problems are difficult. In the early stages of our study, we may possibly feel that each problem by which we are challenged might well be saved until we are better prepared to face it. But this preparation can only be gained by plunging ahead with whatever equipment we possess.

1. SCIENCE DEALS WITH PROBLEMS

A. The Scope of Science[1]

BY KARL PEARSON

Now this is the peculiarity of scientific method, that when once it has become a habit of mind, that mind converts *all* facts whatsoever into science. The field of science is unlimited; its material is endless, every group of natural phenomena, every phase of social life, every stage of past or present development is material for science. *The unity of all science consists alone in its method, not in its material.* The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science. The facts may belong to the past history of mankind, to the social statistics of our great cities, to the atmosphere of the most distant stars, to the digestive organs of a worm, or to the life of a scarcely visible bacillus. It is not facts themselves which make science, but the method by which they are dealt with. The material of science is co-extensive with the whole physical universe, not only that universe as it now exists, but with its past history and the past history of all life therein. When every fact, every present or past phenomenon of that universe, every phase of present or past life therein, has been examined, classified, and co-ordinated with the rest, then the mission of science will be completed. What is this but saying that the task of science can never end till man ceases to be, till history is no longer made, and development itself ceases?

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[1] Taken from *The Grammar of Science* (3d ed.), Part I, pp. 12–14. London: Adam & Charles Black, Ltd., 1911.

It might be supposed that science has made such strides in the last two centuries, and notably in the last fifty years, that we might look forward to a day when its work would be practically accomplished. At the beginning of this century it was possible for an Alexander von Humboldt to take a survey of the entire domain of then extant science. Such a survey would be impossible for any scientist now, even if gifted with more than Humboldt's powers. Scarcely any specialist of to-day is really master of all the work which has been done in his own comparatively small field. Facts and their classification have been accumulating at such a rate, that nobody seems to have leisure to recognise the relations of sub-groups to the whole. It is as if individual workers in both Europe and America were bringing their stones to one great building and piling them on and cementing them together without regard to any general plan or to their individual neighbour's work; only where some one has placed a great corner-stone is it regarded, and the building then rises on this firmer foundation more rapidly than at other points, till it reaches a height at which it is stopped for want of side support. Yet this great structure, the proportions of which are beyond the ken of any individual man, possesses a symmetry and unity of its own, notwithstanding its haphazard mode of construction. This symmetry and unity lie in scientific method. The smallest group of facts, if properly classified and logically dealt with, will form a stone which has its proper place in the great building of knowledge, wholly independent of the individual workman who has shaped it. Even when two men work unwittingly at the same stone they will but modify and correct each other's angles. In the face of all this enormous progress of modern science, when in all civilised lands men are applying the scientific method to natural, historical, and mental facts, we have yet to admit that the goal of science is and must be infinitely distant.

For we must note that when from a sufficient if partial classification of facts a simple principle has been discovered which describes the relationship and sequences of any group, then this principle or law itself generally leads to the discovery of a still wider range of hitherto unregarded phenomena in the same or associated fields.[1] Every great advance of science opens our eyes to facts which we had failed before to observe, and makes new demands on our powers of interpretation. This extension of the material of science into regions where our great-grandfathers could see nothing at all, or where they would have declared human knowledge impossible, is one of the most remarkable features of modern progress. Where they interpreted the motion of the planets of our own system, we discuss the chemical constitution of stars, many of which did not exist for them, for their telescopes could not reach them. Where they discovered the circulation of the blood, we see the physical conflict of living poisons within the blood, whose battles would have been absurdities for them. Where they found void and probably demonstrated to their own satisfaction that there was void, we conceive great systems in rapid motion capable of carrying energy through brick walls as light passes through glass. Great as the advance of scientific knowledge has been, it has not been greater than the growth of the material to be dealt with. The goal of science is clear—it is nothing short of the complete interpretation of the universe. But the goal is an ideal one—it marks the *direction* in which we move and strive, but never a stage we shall actually reach. The universe grows ever larger as we learn to understand more of our own corner of it.

B. The Scientific Attitude[2]

BY EDWARD BRADFORD TITCHENER

The attitude of science, to begin with that, is before all things a *disinterested* attitude: witness the rise and growth of astronomy, of chemistry, of physiology. Until mankind has learned to take experience in serious earnest "for its own sake," to subordinate personal ends to the pursuit of truth, there is no science, but only something which at its worst is quackery and pseudo-science, at its best common sense and rule of thumb; and conversely, so soon as a man starts out to examine some aspect of experience as if it were for itself important and knowledge of it were intrinsically desirable, so soon does the germ of a science appear. For the race, the learning of this lesson was difficult enough; and so, in the large, the negative form of the adjective—disinterested—may be justified; science sets aside the oldest and what we might consider the most natural interests of man. For the individual, on the other hand, a positive term would be more suitable. The curiosity or, as Helmholtz named it, the *Wissensdrang* which marks the scientific temperament renders the "disinterested" work of science the most interesting thing, as Helmholtz also said, that its possessor can find to do. The adjective must be kept, partly for its historical associations, and partly because the writer can not think of a positive word that should replace it; but it must be understood, when the worker in science, the scientifically-minded individual is in question, as meaning self-fulfilment rather than self-renunciation. Otherwise, science would never have had its martyrs.

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[1] For example, while in the last two decades our theory of light and magnetism has advanced by leaps and bounds, we have, at the same time, discovered wide ranges of novel phenomena, of which we had previously no cognisance.

[2] Taken from "Psychology: Science or Technology?" *Popular Science Monthly*, LXXXIV (1914), 42–43.

The scientific attitude, then, is disinterested; the point of view of science is one that shall reveal the unvarnished fact; so much we are plainly taught by the history of science. We gather from the same source that the method of science is *observation*. All the "facts" of science are gained by a disinterested observation; sometimes, by an unaided observation; more often, since the conditions are complex, by the roundabout way—which is still observation—of experiment and measurement. We need not pause to illustrate, or to cite the authorities; the conclusion is generally accepted; and every piece of apparatus in our laboratories shows as an instrument for the control or the extension or the refinement of observation.

It is, perhaps, less apparent that all the problems of science may be summed up in the single problem of *analysis;* that the task which lies before the man of science, in his character as scientific, is always the analysis—under which is included, of course, that synthesis which is a test of analysis—of some complex object or complex situation. The reduction of a compound to its elements, the differentiation of factors, the establishment of correlations among the components of a given whole,—these are the things that the scientific investigator finds himself doing. True, we shrink a little from running all men of science into the same mold; we individualize them; we think of Newton as wielding "the ponderous instrument of synthesis," of Darwin as "working on true Baconian principles, and without any theory collecting facts on a wholesale scale." We are right in thus individualizing; for not only is the man of science something more than a scientific machine, but science itself is also something more than what we have so far made it out to be. The witness of history is, nevertheless, straightforward enough; what Newton and Darwin, as scientific men, had before all things to do was to analyze, and to analyze again, and again to analyze. To be scientifically active is disinterestedly to apply the method of observation to the task of analysis.

C. Scientific Judgment and Opinion[1]

BY EDWARD L. THORNDIKE

The judgments of science are distinguished from the judgments of opinion by being more impartial, more objective, more precise, more subject to verification by any competent observer, and by being made by those who by their nature and training should be better judges.

Science knows or should know no favorites and cares for nothing in its conclusions but their truth. Opinion is often misled by the "unconscious logic of its hopes and fears," by prepossessions for or against this or that book or method or result. Science pays no heed to anything but the facts which it has already made sure of; it puts nothing in the scales but objective evidence. Opinion trusts its personal impressions, bows to authority and follows the crowd. Anyone's opinion constantly favors the methods he is used to and is suspicious of new ideas except his own; it accepts without verification and rejects without a fair trial. Science seeks precise quantitative measures of facts by which changes and correspondences may be properly weighed; opinion is content to guess at amounts of difference and likeness, to talk in the vague terms of more or less, much and little, to rate a method as better or worse without taking the pains to find out just how much better or worse it is. Science reveals the sources of its evidence and the course of its arguments, so that any properly equipped thinker can verify for himself the facts asserted to be true. Opinion offers itself to be accepted or rejected, but not to be verified or intelligently criticised. Science is the work of minds specialized to search after truth and selected as fit for the work by their equals and superiors in it. Opinion is the occasional thought of those who, though important and capable people, are yet only amateurs in the work of getting truth.

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[1] Taken from *The Principles of Teaching*, pp. 265-66. New York: A. G. Seiler, 1913.

EXERCISES

1. Pearson states that it is not so much a matter of the material with which you deal as it is the way in which you deal with it that makes work scientific or unscientific. Describe some specific conditions under which the facts of football playing, club life, and the automobile might be considered facts of science.
2. If each scientific discovery simply increases the number of unsolved problems, what is the use of continuing scientific work?
3. What, in your mind, are likely to be the advantages and disadvantages of the impersonal attitude in science?

2. SHOULD SCIENCE DEAL WITH MIND?

A. The Good Man's Croft[1]

BY W. K. CLIFFORD

What is the domain of Science? It is all possible human knowledge which can rightly be used to guide human conduct.

In many parts of Europe it is customary to leave a part of the field untilled for the Brownie to live in, because he cannot live in cultivated ground. And if you grant him this grace, he will do a great deal of your household work for you in the night while you sleep. In Scotland the piece of ground which is left wild for him to live in is called "the good man's croft." Now there are people who indulge a hope that the ploughshare of Science will leave a sort of good man's croft around the field of reasoned truth; and they promise that in that case a good deal of our civilizing work shall be done for us in the dark, by means we know nothing of. I do not share this hope; and I feel very sure that it will not be realised. I think that we should do our work with our own hands in a healthy straightforward way. It is idle to set bounds to the purifying and organizing work of Science. Without mercy and without resentment she ploughs up weed and briar; from her footsteps behind her grow up corn and healing flowers; and no corner is far enough to escape her furrow. Provided only that we take as our motto and our rule of action, Man speed the plough.

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[1] Taken from *Lectures and Essays*, II, 50–51. New York: Macmillan & Co., 1901.

B. Early Obstacles to Progress[1]

BY HERMANN EBBINGHAUS

The general causes which have checked the progress of psychology and thus made it fall behind the others can readily be stated:—

"The boundaries of the Soul you cannot find, though you pace off all its streets, so deep a foundation has it," runs a sentence of Heraclitus, and it hits the truth more fully than its author could ever have expected. The structures and functions of our mental life present the greatest difficulties to scientific investigation, greater even than those presented by the phenomena, in many respects similar, of the bodily life of the higher organisms. These structures and processes change so unceasingly, are so fleeting, so enormously complex, and dependent on so many factors hidden yet undoubtedly influential, that it is difficult even to seize upon them and describe their true substance, still more difficult to gain an insight into their causal connections and to understand their significance. We are just now beginning to recognize the full force of these difficulties. Wherever in recent years research in any of the many branches of psychology has made any considerable advance,—as in vision, audition, memory, judgment, —the first conclusion reached by all investigators has been, that matters are incomparably finer and richer and fuller of meaning than even a keen fancy would previously have been able to imagine.

There is, besides, a second obstacle. However difficult it may be to investigate the nature and causal connections of mental phenomena, everybody has a superficial knowledge of their external manifestations. Long before these phenomena were considered scientifically, it was necessary for practical human intercourse and for the understanding of human character, that language should give names to the most important mental complexes occurring in the various situations of daily life, such as judgment, attention, imagination, passion, conscience, and so forth; and we are constantly using these names as if everybody understood them perfectly. What is customary and commonplace comes to be self-evident to us and is quietly accepted; it arouses no wonder at its strangeness, no curiosity which might lead us to examine it more closely. Popular psychology remains unconscious of the fact that there are mysteries and problems in these complexes. It loses sight of the complications because of the simplicity of the names. When it has arranged the mental phenomena in any particular case under the familiar designations, and has perhaps said that some one has "paid attention," or has "given free rein to his imagination," it considers the whole matter explained and the subject closed.

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[1] Adapted from *Psychology, an Elementary Text-Book*, pp. 3–9. (Translated and edited by Max Meyer.) Boston: D. C. Heath & Co., 1908.

Still a third condition has retarded the advance of psychology, and will probably continue to do so. Toward some of its weightiest problems it is almost impossible for us to be open-minded; we take too much practical interest in arriving at one answer rather than the other. King Frederick William I was not the only person who could be persuaded of the danger of the doctrine that every mental condition is governed by fixed law, and that in consequence all of our actions are fully determined—a doctrine fundamental to serious psychological research. He believed that such a teaching undermined the foundations of order in state and army, and that according to it he would no longer be justified in punishing deserters from his tall grenadiers. There are even to-day numerous thinkers who brand such a doctrine dangerous. They believe that it destroys all possibility of punishment and reward, makes all education, admonition, and advice meaningless, paralyzes our action, and must because of all these consequences be rejected. . . . .

In order to understand correctly the thoughts and impulses of man, we must treat them just as we treat material bodies, or as we treat the lines and points of mathematics. The pretended dangers of such a conception of things disappear, as soon as we face them without prejudice and try to understand them. The conception may be misused, especially by people of immature mind, but "for whatever purpose truth may be used, true still remains true," and the question is not, "what is fit to be preached, but what is true."

C. A Philosophical Orientation[1]

BY JOHN FREDERICK DASHIELL

When human psychology is referred to as a natural science, the general reader is in danger of drawing false implications. It has been stated that its proper subject-matter is man, taken as a complex physical object in interaction with a world of other physical objects. Such a naturalistic study of human beings and their modes of activity should be completely divorced from humanistic considerations, not because it is opposed to them, but because it is independent of them and irrelevant. To look at man in this way for purposes of obtaining objective, impersonal, unbiased knowledge of how and why he behaves just as he does, does not make life any the less wholesome nor at all threaten other inherent values of human life.

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[1] Taken by permission from *Fundamentals of Objective Psychology*, pp. 14–17. Boston: Houghton Mifflin Co. Copyrighted, 1928.

The Origins of the Natural Sciences. Philosophy is the mother of all the sciences. Go back to the earliest exponents of philosophical thinking, the "Pre-Socratics," and it will be seen that their philosophical inquiries were addressed to all things. Those inquiries involved a general curiosity about atmosphere, sun, moon, stars, evolution, human breath, animal death, the basis of kindness, the advantages of self-love, the number system, the nature of space and time, sex differences, theology, the music of the spheres. Philosophy was truly "a love of wisdom." But as the study of events in the world of nature advanced, man came to discover the distinct advantage of pursuing such study in a detached, objective manner, putting aside his own desires and wishes in such matters.

Aristotle framed a classification of the natural sciences much as we have it to-day in our various "'ologies." These sections of the field of knowledge remained, however, largely a matter of philosophical interest for many centuries, and it was only with the elaboration of refined experimental and observational methods in the fourteenth and fifteenth centuries that the study of the natural world began to take the form of distinct sciences. As the technique of investigation became elaborate and specialized, some methods were found more especially applicable to the study of one kind of natural events, other methods to others, and the specializing and departmentalizing of knowledge led to a definite splitting off of the natural sciences from the mother stream of thought, philosophy.

In the separation of particular fields of investigation for the application of specialized technique, mathematics and the sciences of astronomy and physics were the earliest to attain an independent status. Later, chemical phenomena became the object of a special science. Still later, the more complicated facts about living matter were treated experimentally, and anatomy and physiology, botany and zoölogy were marked off as separate scientific fields. On the heels of these changes has come the making over of psychology. Whereas it was formerly an armchair contemplation of man, which one writer has called "mind-gazing," it has now become an accurate experimental science.

Philosophical *versus* Scientific Attitude. Two distinctions may be pointed out between philosophical and scientific thinking. The former is speculative. Not limiting itself to definite, obtained, actually observed facts, it goes beyond them with the intent of developing ultimately a satisfactory *Weltanschauung*—a world-view, in which the limited and incomplete facts, opinions, conjectures will be included and given perspective. On the contrary, scientific thinking limits itself rigorously to the data of observation and to the fewest and simplest hypotheses and demonstrated laws to be derived from those data.

A second trait of philosophical thinking is its evaluating character. So far as the philosopher is interested in "facts" he is concerned with their importance and their value especially in connection with ideals, desirable ends, or programs, conceived in the broadest senses. He may judge another's conduct in ethical terms as "good" or "bad," "worthy" or "unworthy." He may make aesthetic judgments of scenery or of statuary as "beautiful" or "ugly." He may give logical judgments as to the validity and cogency of certain assertions and arguments. In these and other sides of his life as philosopher, man is occupied with the rating and valuing of things, the considering of what is worth while and desirable. It is only the everyday attitude grown reflective. The natural scientist, on the other hand, strives to maintain an impersonal, objective, non-valuing, non-committal attitude of considering facts for facts' sake.

But viewing facts for their own sake alone is an inconceivable ideal. This interest in the pure sciences is after all based upon the more fundamental human interest in applications—applications for the purpose of getting some practical hold on the environment.

Let the natural sciences be thought of as a field in which men apply a certain special technique to gain a better control of things, so that those things can be used more efficaciously to meet man's wants and make life better, more lovable, and more ideal. Then we can see that a study of the sciences does not at all threaten any humanistic values. The study of man as an objective thing does not challenge the various ways of evaluating man's life in terms of the various relations in which he is found. But if we can by such study get at what actually causes, influences, and determines man's behavior we can then control man better, or control the things that can make him happy. The study of habit making and habit breaking may be carried on without considering whether the habits are good or bad. But when we know something about habit making and breaking, we can apply that pure-science knowledge to the more efficient development of good character in man as averse to bad. Having determined just what conditions will produce a given result in the behavior of a person, we are able to create with some accuracy certain types of behavior by setting up the conditions which have been demonstrated to produce this behavior.

EXERCISES

1. What are some of the "good man's crofts" that you have observed in your own experience?
2. Why is science so insistent that no phenomena occur without cause?
3. Enumerate some facts from your own observations which seem to be causeless or accidental. Are they or are they not actually careless? Why do you think so?

3. THE DEFINITION AND SUBJECT-MATTER OF PSYCHOLOGY

A. What Psychology Is Not[1]

BY KNIGHT DUNLAP

It is much easier to tell the beginner what psychology is *not* than it is to tell him what psychology is. Just as it would be impossible to give an intelligible definition of mathematics to a person unfamiliar with the elementary principles of number-relations, so it is impossible to make clear to the average student the nature of psychology when he is just beginning to study it. In order that one may have a definite idea of what psychology is, he must know some psychology; and a person who has not studied the subject under competent guidance is not apt to know any psychology in the strict sense. It is true, on the one hand, that there is a great deal of information which is popularly called psychological; and, on the other hand, that every person knows much that is really psychology, although the persons in question do not realize that it is such. These two species of misunderstanding contribute to the difficulty of the task when one commences to study the subject scientifically. It is clear, therefore, that what we say now in a general way concerning psychology should be brief, and that the meaning thereof will probably be clear to the student only as he reverts to it after completing the volume.

We may commence advantageously by warning the student against some of the more common misconceptions of psychology. In the first place, while on the one hand psychology is not the "study of the soul," on the other hand it is not "soulless" in the sense of doing away with a soul. It is a commonplace that a considerable portion of the psychological discussion gets along without any mention of any sort of "soul." But in a comprehensive analysis it is not possible to avoid reference to something which may properly be called a "soul," although it is by no means the "psyche" of the Greeks and of the current popular conception, and although it is impossible really to study it.

In the second place, psychology deals very little with the so-called "occult"; with telepathy, clairvoyance, and the other charlatanisms which are often so successfully employed in separating the fool from his money. Yet if we do not affirm, neither do we deny, that there may be, at the core of some of these concretions of humbuggery, certain elements of psychological interest and importance. The investigation of such matters belongs, however, not properly to psychology, but to "psychic research."[1]

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[1] Taken from *A System of Psychology*, pp. 1–4. New York: Charles Scribner's Sons. Copyrighted, 1912.

In the third place, the term "psychological" in current popular usage designates a certain delicacy or niceness of discrimination or adjustment. Thus the "psychological moment" implies an instant of time so appropriate for a certain act that a moment before would be too early, and a moment after too late. Any very precise analysis or description, of the characteristics and activities of human beings; or even a simulation of precision, is called "psychological"; and hence we find mention of "psychological" novels, and so forth. Now while psychology modestly acknowledges the pretension to exactness of analysis, she must deny any exclusive claim thereto, and cannot even pose as the only science which analyzes human activity and experience. In this popular sense of the term, physiology, logic, and ethics are, if anything, more "psychological" than is psychology.

Finally, psychology is not the study of the functions of the nervous system. In fact, all the essential points of psychology can be expounded, as they have been developed, without reference to the nervous system, or by reference to a conception thereof which is ridiculously inaccurate. Nevertheless, it is true that psychological principles and facts are more easily described and investigated when referred to the structure and probable activity of the brain and nerves, as understood by the person to whom described or by whom investigated, and we believe that the more closely the physiological conceptions approach agreement with the actual facts of structure and function, the more facile the progress of psychology.

B. The Study of Consciousness or Mind

I[2]

BY GEORGE TRUMBULL LADD

Although it requires much time and study to form a worthy conception of the science (its nature, method, and aims) of which we are to treat, the following preliminary statement will be of use: *Psychology is the systematic description and explanation of the phenomena of con-*

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[1] The terms "psychic" and "psychical" must be distinguished carefully from "psychological." It is to be regretted that either of the first two terms is ever applied to the data which we study in the name of psychology.

[2] Taken from *Outlines of Descriptive Psychology, etc.*, pp. 1–2. New York: Charles Scribner's Sons. Copyrighted, 1902.

sciousness, as such. For the phrase "phenomena of consciousness," such terms as "conscious states," or "processes," "psychical (or mental) activities," or even the technical word "psychoses," may sometimes be substituted. For the principal classes of these phenomena the familiar words, sensations, feelings, ideas, memories, imaginings, thoughts, sentiments, decisions, choices, etc., must often be employed. What all these conscious states in fact are, and what conditions accompany and determine them, every adult knows to some extent by his own experience. But the complex *structure*, so to speak, and the manifold *causes* and *connections* of many of them still baffle the supremest efforts of expert inquirers. What these phenomena actually are, as conscious states, and how they come to exist and to follow each other in the order which they in fact assume, forms the primary subject of the investigations of psychology.

Our definition has restricted the sphere of psychology to conscious states, or psychoses, *as such.* This rather uncouth way of helping out the formula is necessary, for the following reasons. From a certain point of view (and this is the distinctly psychological), all the sciences may be regarded as only "systematic description and explanation" of man's conscious states. Science itself is a human psychical activity; it is systematic and verifiable knowing. And since there is no such thing as knowing in general, every scientific fact or law is, in what is called its *subjective* aspect, somebody's perception, imagination or cognition. That which, for the scientific botanist, is a real thing, a tree or a plant, is for psychology a "phenomenon of consciousness"; it is in either case a perception or conception to which the attribute of "scientific" or "unscientific" may be ascribed. The scientific geologist, too, gathers the facts of his science only by his own observation, or by belief in the reports given by others of their observations,—in either case, helped out by imagination and memory. His scientific generalizations are, therefore, for the psychologist the conclusions of the mind's observing and reasoning processes; they are judgments, thoughts, conjectures, as to what is true or was true. But judgments, thoughts, conjectures, etc., are psychical events; they never are, and never can be, anything, *in themselves considered*, but conscious states.

Now it is "in themselves considered"—the perceptions by the senses, the memories, thoughts, conjectures, *as such*—that the psychologist studies the phenomena of consciousness.

II[1]

BY EDWARD BRADFORD TITCHENER

Psychology is the science of mind. What, then, is mind? Everybody knows that, you will say, just as everybody knows what is matter. Everybody knows, yes, in terms of common sense; but we have seen that common sense is not science. Besides, common sense is not articulate; it cannot readily express itself; and it is a little afraid of plain statements. Close this book, now, and write down what *you* take mind to be; give yourself plenty of time; when you have finished, go over what you have written, and ask yourself if you really know what all the words and phrases mean, if you can define them or stand an examination on them; the exercise will be worth while.

Open the book again! The exercise was worth while; but it was not quite fair. For the fact is that these great comprehensive words that we all use and all understand cannot be rigorously defined; they are too old; they have lived through too many changes; they have gathered about them too many conflicting associations. They pass muster in our everyday discourse only because we take them for granted and do not scrutinise them too closely. The expert alone can say what common sense means by mind; and even the expert must speak in general terms, qualifying and with reservations.

It seems, however, that the prime factor in the **common-sense notion of mind** is the idea of activity. We ascribe to mind the same sort of voluntary and purposeful activity that we ascribe to our fellow-men; and we distinguish this activity from the blind necessity of cause and effect. We find ourselves, and those about us, deliberating, intending, resolving, planning, recalling, doubting; and we say that these and similar activities are activities of mind. We also find ourselves, and those about us, breathing, secreting, moving; but here we draw distinctions. Breathing, we say, is a physical affair, though we may hold the breath by an act of will. Secretion results from some physical or chemical cause; only if we cry for sorrow or sweat for fear is mind influencing body. Walking and blinking may be physical only; but if we turn our steps by intention into a certain path, or blink on purpose to clear our sight, the physical movements become subject to the action of mind.

So long as we stick to examples, all this seems straightforward; only it is not easy to decide whether mind is activity, or whether these various activities are activities of mind. On the whole, common sense leans to the latter view; the activities are manifestations of mind. Mind itself is then something immaterial, lying behind the manifestations. What sort of thing? Apparently, another human being, an inner man that dwells within the outer man, an insubstantial mannikin living inside the head. Does that sound absurd? But it did not seem absurd just now to read that we ascribe to mind the same sort of voluntary and purposeful activity that we ascribe to our fellow-men; and how could we do that unless mind were something like a human being? This inner man appears, in fact, to be the mind of common sense; the inner man thinks, reflects, remembers, desires; he is influenced by the outer man, becoming gloomy and morose when his host cannot digest; and he influences the outer man, who sheds tears when his inmate is grieved. A curious view, when we write it out and think of it in cold logic; but a view that we should understand if we traced the growth of common sense from its first beginnings; and a view of highly respectable antiquity. Very ancient superstitions are connected with the man who is seen in the eye; the Egyptian *ka* or spirit-double is a smaller copy of the outer man; Greek vase-paintings show the human soul as a tiny human being; primitive thought has from time immemorial explained, and the modern savage still explains, the life and motion of man, or his repose in sleep and death, by the presence or absence of the little creature normally at work within him.

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[1] Taken by permission from *A Beginner's Psychology*, pp. 5–9. New York: Macmillan Co. Copyrighted, 1915.

Yet however natural a view like this may be, science can make nothing of it. For one thing, it merely pushes the problem a step further back. The inner man acts on the outer man and is acted on by him; but who or what gives the inner man, in his turn, the power to influence and to be influenced? We must suppose an endless nest of mannikins. That and other such arguments apart, however, the view is non-scientific because it offers an interpretation and not a description of mind. *The mind with which psychology deals must be a mind that is describable in terms of observed fact;* otherwise it cannot form the subject-matter of a science. So we must start afresh, and ask what mind is, when mind is looked at from the scientific point of view.

You will better understand the answer to this question when you have worked through the book. The answer will then have been given in the concrete and particular; now it can be given only in the abstract and general. Remember that it is given, nevertheless, in terms of work done and results obtained; it is not an answer that the psychologist makes up beforehand, but one that he himself has been led to in the course of his attempt to work scientifically upon mind. In brief it is this:

We find that the field of science has been surveyed from two different standpoints. Men of science have set out, on the one hand, to describe the world as it would be with man left out. The result is what we call physical science. The world of physics is colourless, toneless, neither cold nor warm; its spaces are always of the same extent, its times are always of the same duration, its mass is invariable; it would be just what it is now if mankind were swept from the face of the earth. For what is light in the textbooks of physics?—a train of electromagnetic waves; and sound is a vibratory motion of air or water; and heat is a dance of molecules, and all these things are independent of man. But men of science have tried, on the other hand, to describe **the world as it is in man's experience,** as it appears with man left in; and the result of this endeavour is psychology. The world of psychology contains looks and tones and feels; it is the world of dark and light, of noise and silence, of rough and smooth; its space is sometimes large and sometimes small, as everyone knows who in adult life has gone back to his childhood's home; its time is sometimes short and sometimes long; it has no invariables. It contains also the thoughts, emotions, memories, imaginations, volitions that you naturally ascribe to mind; it contains, that is, so much of these things as belongs to the sphere of observable fact. It is obviously very different from the world of physics, though both worlds alike have been opened up to us by science, by the impersonal and disinterested search for facts.

So we have a world of matter and a world of mind. The physicist, however, describes and measures the various phases of energy, without assuming any material substance in the background, any matter of which this energy is the manifestation. Matter, if the word is to be used at all, is simply the inclusive name for all the forms of energy. And the psychologist, in the same way, describes and measures—so far as he is able to measure—the phenomena of his world, without assuming any active or perduring mind in the background; for him, mind is simply the **inclusive name of all these phenomena.** That is the first rough answer to our question. Much more must be said, if the answer is to be precise; but even as it is we have travelled a long way from the little man living inside the head!

III[1]

BY MADISON BENTLEY

We all know that thoughts and emotions, desires and memories, somehow belong to the domain of the psychologist, just as we all know that the study of heat falls to the physicist and the explanation of the action of acid on marble to the chemist. Of course such a vague reference of obvious and familiar facts to their proper subjects of study does not imply either an exact knowledge of the facts themselves or our ability to speak the language of any one of the sciences. But we have to begin with the scraps of information already acquired if we are to progress in our serious inquiries after knowledge.

Our common experiences are continually suggesting the physical sciences, the sciences of matter and energy, of life and of the constitution of the earth; but just as much do they constantly hint at things "psychological" in the homely events of every day. When you have ridden at the wheel of a motor-car you must have observed a connection between the speed of the car and your thoughts and feelings. The exhilaration of a crisp morning and of a free conscience is likely to be reflected in an open throttle and a contempt for curves; while baffled thinking and uncertain plans bring the car down to the pace of a snail. Decision, resolves, high moods and firm intent tell in the one direction; indecision, doubt and depression in the other. "Consciousness" or "the mind," as we say, has obtruded. It obtrudes also when an electric sign flashes past and leaves a greenish ghost or "after-image" as you drive on into the night.

The same kind of hint is given with the violent expression of feeling in the grand stand under an unpopular decision, or with a quiet exhibition of sustained fortitude in crushing sorrow. Feelings seem to lie at the very heart of mind. The dentist's office is painfully alive with "psychological" facts; the intimate roar and crunch of the drill, the sharp stab of the probe, the curious withdrawal of sights and sounds under the anaesthetic, and the gradual return to "consciousness." And less thrilling and impressive occasions have just as much their obvious "mental" aspects. You give up the quest for a forgotten name and suddenly find yourself pronouncing it without the least effort; you realize as you walk that a melody or a bit of dance music has been "running through your head"; or you learn to devote yourself to study in spite of noise and distraction. You note the lure of the brilliantly colored advertisement on the boards, the blind fury of the riotous mob, the ease of right-hand writing as compared with the awkward attempts with the left hand, the tongue's exaggeration of the size of a dental cavity, the shifting temper of a nation under the fortunes of war, the play of animals, and the short cuts of genius. Everywhere in daily experience are hints that we move as constantly and as naturally in the realm of "the mental" as among objects of the physical order.

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[1] Adapted from *The Field of Psychology*, pp. 1–4. New York: D. Appleton & Co., 1924.

Out of such stuff, then, exposed in its raw state, psychology collects and selects its materials. But the materials must be refined. Merely to note such experiences as the foregoing, even though they be our very own, will no more make a psychologist than traffic in eggs will open the door to embryology. We must plainly mark the distinction between intimate acquaintance and scientific knowledge. Were intimate acquaintance a substitute for systematic and orderly knowledge, we might look for our most famous botanists in tropical jungles, for anatomists in the great meat-packing concerns, and for psychologists among the crowded tenements.

So it is not by chance that psychology develops, as physics, anatomy, and embryology develop, in the laboratory and in the study. For here distracting interests and practical considerations drop away; the material is simplified, sorted, set into its proper context, and at last filed with other records of the science. The after-image from the electric sign, for example, is here reproduced under the controlled conditions of experiment, repeated and varied at will and compared with other like phenomena. It then takes its place in the psychology of vision. So also the colored advertisement is withdrawn from the distractions of the street; it is studied as one of the means of "turning the mind" in a new direction, and thus it suggests a problem in attention. In the same way, the facts of insanity fall under the problems of the abnormal; idiocy and genius become matters for research upon capability; the orator and his audience are transmuted into problems upon the social integration of men; the "tune in the head" turns out to be a typical bit of auditory imagery; right-hand writing is made a study in the habituation of function, and grief takes its place among the emotions.

We see, then, that psychological materials lie all about us in the experiences of every day; but we see also that these materials are not really incorporated into psychology until they are regarded by the trained observer, withdrawn for more favorable conditions of study, and passed through the alembic of the science.

C. The Study of Behavior[1]

BY JOHN BROADUS WATSON

A psychology of interest to all scientific men would take as its starting point, first, the observable fact that organisms, man and animal alike, do adjust themselves to their environment by means of hereditary and habit equipment. These adjustments may be very adequate or they may be so inadequate that the organism barely maintains its existence; secondly, certain stimuli lead the organisms to make the responses. In a system of psychology completely worked out, given the responses the stimuli can be predicted; given the stimuli the responses can be predicted. Such a set of statements is crass and raw in the extreme, as all such generalizations must be. Yet they are hardly more raw and less realizable than the ones which appear in the psychology texts of the day. The point might better be illustrated by choosing an everyday problem which any one is likely to meet in the course of his work. Some time ago the author was called upon to make a study of certain species of birds. Until he went to Tortugas he had never seen these birds alive. On reaching this island he found the animals doing certain things; some of the acts seemed to work peculiarly well in such an environment, while others seemed to be unsuited to their type of life. The responses of the group as a whole were first studied and later those of individuals. In order to understand more thoroughly the relation between what was habit and what was hereditary in these responses, the young birds were captured and reared. In this way it was possible to study the order of appearance of hereditary adjustments and their complexity, and later the beginnings of habit formation. The attempts to determine the stimuli which called forth such adjustments were crude indeed. Consequently the attempts to control behavior and to produce responses at will did not meet with much success: food and water, sex and other social relations, light and temperature conditions were all beyond control in a field study. It was found possible to control their reactions in a measure by using the nest and egg (or young) as stimuli. It is not necessary here to develop further how such a study should be carried out and how work of this kind needs to be supplemented by carefully controlled laboratory experiments. Were the task to examine the behavior of some of the Australian tribes the method adopted would have been much the same, but the problem would have been more difficult: the types of responses called forth by physical stimuli would have been more varied, and the number of effective stimuli larger. The social setting of their lives would have had to be examined in a far more careful way. These savages would naturally be far more influenced by the responses of each other than was the case with the birds. Furthermore, habits would have been more complex and the influence of past habits upon present responses would have appeared more clearly. Similar but more complex problems would arise in working out the psychology of a cosmopolitan race, but the method of attacking them would be the same. In the main, the desire in all such work is to gain an accurate knowledge of adjustments and the stimuli calling them forth. The reason for this is to learn general and particular methods by which behavior may be controlled. The goal is not "the description and explanation of states of consciousness as such," nor that of obtaining such proficiency in mental gymnastics that one can immediately lay hold of a state of consciousness and say, "this, as a whole, consists of gray sensation number 350, of such and such extent, occurring in conjunction with the sensation of cold of a certain intensity; one of pressure of a certain intensity and extent," and so on *ad infinitum*. If psychology would follow the plan suggested, the educator, the physician, the jurist, and the business man could utilize the data in a practical way, as soon as it could be experimentally obtained.

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[1] Taken from *Behavior, an Introduction to Comparative Psychology*, pp. 10–11. New York: Henry Holt & Co., 1914.

D. The Study of Purposeful Behavior[1]

BY WILLIAM MC DOUGALL

We may define psychology as the positive science of the behaviour of living things. To accept this definition is to return to the standpoint of Aristotle, and to set out from generally recognized facts, unprejudiced by theories. We all recognize broadly that the things which make up our world of perceptible objects fall into two great classes, namely, inert things, whose movements and changes seem to be strictly determined according to mechanical laws, and living things, which behave or exhibit behaviour; and, when we say that they exhibit behaviour, we mean that they seem to have an intrinsic power of self, determination, and to pursue actively or with effort their own welfare and their own ends or purposes.

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[1] Taken from *Psychology, the Study of Behaviour*, pp. 19–25. New York: Henry Holt & Co., 1912.

The manifestation of purpose or the striving to achieve an end is, then, the mark of behaviour; and behaviour is the characteristic of living things. This criterion of life is one of which we all make use; but most of us have not reflected upon it, and we may dwell upon it for a moment with advantage. Take a billiard ball from the pocket and place it upon the table. It remains at rest, and would continue to remain so for an indefinitely long time, if no force were applied to it, no work done upon it. Push it in any direction, and its movement in that direction persists until its momentum is exhausted, or until it is deflected by the resistance of the cushion and follows a new path mechanically determined. This is the type of mechanical movement. Now contrast with this an instance of behaviour. Take a timid animal such as guinea-pig, from its hole or nest, and put it upon the grass-plot. Instead of remaining at rest, it runs back to its hole; push it in any other direction, and, as soon as you withdraw your hand, it turns back towards its hole; place any obstacle in its way, and it seeks to circumvent or surmount it, restlessly persisting until it achieves its end or until its energy is exhausted.

That is an example of behaviour from the middle region of the scale of complexity; consideration of it reveals very clearly the great difference between behaviour and mechanical process. As an instance higher in the scale of complexity, consider a dog taken from its home and shut up at some distant place. There, no matter how kindly treated, he remains restless, trying constantly to escape and, perhaps, refusing food and wasting away; when released, he sets out for home, and runs many miles across country without stopping till he reaches it, following perhaps a direct route if the country is familiar to him, or perhaps only reaching home after much wandering hither and thither.

As an example from the upper end of the scale of behaviour, consider the case of a man who loves his native land, but who, in order to earn his daily bread, has accepted a position in some distant country. There he faithfully performs the tasks he has undertaken; but always his dominant purpose is to save enough money to enable him to return and to make a home in his native land; this is the prime motive of all his behaviour, to which all other motives are subordinated. We best understand this last behaviour, if the exile tells us that he constantly pictures to himself his beloved native place and the enjoyments that he hopes to find there. For we know well what it is to foresee an event and ardently to desire it. Even if the exile be but a dull-minded peasant, incapable of explicitly anticipating the delights of his return, who seems to be affected merely by a homesickness which he cannot express or justify in words, we still feel that we can in some measure understand his state and his behaviour. We feel this also of the dog in the foregoing instance, and in a less degree of the animal of our first example. For we, too, have experienced a vague and formless unrest, an impulsion to strive persistently towards an end which we can neither clearly formulate nor rationally justify; we, too, have experienced how obstruction to such activity does but accentuate our impulse, how successful progress towards the end brings us a vague though profound satisfaction, and how achievement of the end can alone relieve our inward unrest.

These, then, are indisputable instances of behaviour. They are only to be understood or explained after the analogy of our own experiences of effort or striving. No attempt to explain such facts mechanically has at present the least plausibility, or can in any degree aid us in understanding or controlling them. Now the same is true, though perhaps less obviously true, of still simpler forms of behaviour. Let us consider a few in descending order in the scale of complexity.

The migratory bird, arriving in spring, takes up her abode in a coppice, yields to the blandishments of her mate, builds a nest, lays her eggs, and sits upon them, silent and motionless for many days, until the young are hatched. Then, with incessant activity, she cherishes them, feeding them hour by hour and minute by minute, until they attain to independence. With the turn of the year, her great task accomplished, she faces southwards again and, with tireless wings, returns across great tracts of land and sea to her winter home; there to remain until in the following spring she comes back, once more flying thousands of miles to reach the same hedgerow among all the thousands in our English counties, and to repeat there the cycle of her activities. That again is unmistakably a cycle of behaviour. At every stage the actions of the bird may be varied in detail indefinitely; but always they are dominated by the same cycle of purposes in which the great purpose of her life successively manifests itself—the perpetuation of the life of her race according to its specific type and kind. If at any stage her activities are obstructed, her efforts are redoubled; destroy her nest, and she builds another; take away one or more of her eggs, and she lays others to replace them; attack her young, and she resists you with all her feeble powers; shut her up, when the time comes for her flight to Africa, and she beats against the bars that confine her, with ceaseless and varied movements, until she escapes or is exhausted; take away her mate, the indispensable partner of her labours, and she pines, perhaps even to death. How far the bird foresees the ends of her manifold activities we cannot say; though we have good reason to believe that she foresees at each step no more than the immediate effect or end of each step. Yet we cannot doubt that such trains of activity are more closely allied in nature to our own purposive activities than to any sequences of inorganic nature, and that they are therefore properly regarded as behaviour.

Going a stage lower in the scale of life, consider the salmon which, in due season, having attained a certain stage of development in the open sea, enters the mouth of a river, and ascends the stream to deposit its eggs in the bed of some remote tributary. The ascent of a large and swift river containing many rapids and water-falls involves ceaseless and varied efforts extending through a period of many weeks, during which the fish takes no food, but consumes the latent energy of the substance of its muscles. This, too, is an undeniable example of behaviour, which we can only understand in any degree in the light of its analogy with our own behaviour, and which is utterly unlike any phenomenon of inorganic nature.

EXERCISES

1. Why, in your opinion, do psychologists pay relatively little attention to the problems of the "soul," telepathy, clairvoyance, and the like?
2. What difficulties would have confronted Watson if he had tried to study *the conscious states as such* (see Ladd's descriptions of such states) of the birds in the Tortugas?
3. Can you think of any purposeless behavior that you would expect the psychologist to study? Any purposeful behavior that you would not expect him to study?

4. SELF-OBSERVATION OR INTROSPECTION IN PSYCHOLOGY

A. Introspection[1]

BY ROBERT SESSIONS WOODWORTH

Introspection may be defined as the direct observation by an individual of his own mental processes or of the impressions made upon him by external things. It is a form of observation that only the individual himself can make. In practice, there are two quite different forms of introspection. The simpler case is that in which the subject is asked to observe and report the impressions made upon him by external things. You show him, for example, two colors, and ask him which appears the brighter, or it may be the more agreeable. He has a single task to perform, and one which is essentially the same as in objective observation. There is little difference between being asked, "Which of these two colors is the brighter?" and "Which gives you the impression of greater brightness?" In the one case you are supposed to recognize the external fact, and in the other to observe your sensory response to the external fact, but the two come to the same thing in most cases. The only difficulty arises when the observer uses "secondary criteria" of the external fact, and thus judges it without taking account of his impressions of brightness; but such difficulties should be avoided by excluding the possibility of secondary criteria, since it is practically impossible to prevent the subject from being influenced by them if they are present. With this difficulty avoided, no difference remains in practice between this simple form of introspection and ordinary objective observation, and no reason remains for using the special term, "introspection," in referring to this sort of observation.

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[1] Taken from *Dynamic Psychology*, pp. 32–34. New York: Columbia University Press. Copyrighted, 1918.

The more complex sort of introspection occurs in observing inner mental processes. Here the subject has a double task, to carry on the mental operation and to observe it. Since it is difficult and often impossible to perform this secondary task of observation along with the primary task, the only practicable way of getting an observation is first to perform the primary task, and then without delay to turn about and observe what has just passed through your mind. If the mental process is that of solving a problem, first solve your problem, devoting your whole attention to it, and then cast a backward glance over the process and notice what passed through your mind. If the process is of only a few seconds' duration, the backward glance at its close often recovers a good share of it—or so it seems to the subject. But, at best, this form of observation is more difficult than most others that are admitted in scientific work.

Now the behaviorists are perhaps not serious in demanding that the first form of introspection be abandoned, though they appear to say so. If it were discarded, visual after-images, difference tones, and many other so-called "subjective" sensations would have to be dismissed, since they are, as yet, known to us only from introspection. The complex form of introspection could with more approach to justice be ruled out; yet even from it some results have come with such regularity that they command general assent, and probably even the extreme behaviorists in their hearts believe them. The clearest instance would be the becoming automatic and relatively unconscious of an habitual act; but there is much other testimony regarding the processes of learning and the simpler sorts of thinking that is given with such agreement by different observers, and fits so well together, that it can scarcely be rejected by one who takes the trouble to examine it carefully.

B. Objective Observation[1]

BY J. MC KEEN CATTELL

It seems to me that most of the research work that has been done by me or in my laboratory is nearly as independent of introspection as work in physics or in zoölogy. The time of mental processes, the accuracy of perception and movement, the range of consciousness, fatigue and practice, the motor accompaniments of thought, memory, the association of ideas, the perception of space, color-vision, preferences, judgments, individual differences, the behavior of animals and of children, these and other topics I have investigated without requiring the slightest introspection on the part of the subject or undertaking such on my own part during the course of the experiments. It is usually no more necessary for the subject to be a psychologist than it is for the vivisected frog to be a physiologist.

C. Limitations of Objective Observation[2]

BY JAMES R. ANGELL

We may agree that in theory all and in practice much of our mental life might be stated in terms of objective behavior. To do this would involve trespassing rather freely on the preserves of biology, physiology, and neurology on the one side and upon those of the social sciences on the other. But such trespass is perfectly legitimate provided the trespasser is willing to face the chance that he may find himself annexed, appropriated, and in general swallowed up by the owner of the territory which he invades. When she abandons the stronghold of consciousness as her peculiar institution, Psychology is moderately certain to find that as an autonomous government she has ceased to exist and has become a mere dependency of biology or some other overlord. But this change of allegiance is not likely to terrify many of her subjects. The point of view from which not a few of our recent psychologists have conducted their work would make such a shift of emphasis entirely easy. (I count myself among this number.) Whether it is worth while is another matter. Personally, I am disposed to think it is, for the reason that every step forward in that direction renders more obvious the actual vital significance of mental process and this happens to be the thing that interests me. I want to see just how ideas and feelings embody themselves in action and a psychology which makes objective description its main concern must inevitably further this interest.

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[1] Taken from "The Conceptions and Methods of Psychology," *Popular Science Monthly*, LXVI (1904), 180.

[2] Taken from "Behavior as a Category of Psychology," *Psychological Review*, XX (1913), 268–70.

When it comes to discarding introspection I demur. Introspection ought to be checked by every possible objective device, but even for one frankly and exclusively interested in objective behavior as such, it seems to me at present to afford information not to be gained elsewhere. Indeed, we are saturated from childhood on with prepossessions, convictions, ideas, of which we cannot wholly divest ourselves if we would, which have introspection as their foundation and which enter in to color our entire conception of behavior.

At this point too we come upon one of those fundamental lines of cleavage in human interests which cannot be justified, but which nevertheless determine conduct and career. The person to whom mental process as mental process is the only fascinating and ultimately worthy subject of study is not likely to rest content with any such program as that depicted. He justly urges that to recognize and describe the *external expressions* of love, hate, and anger is as different from the actual experience of these thrilling emotions and from the description of them as immediately felt, as is the inspection of a good meal from the consumption of the same. To such an one any abandonment of introspection must seem a pitiful and mean desertion of the real object of worth. Whether this view permanently prevails or becomes an esotoric scientific cult, it is a safe prediction that we shall always have it with us.

It is a wise instinct which science has always followed to glean information wherever it can be found. Until it can be shown, as it has not yet been shown, that introspection is either fundamentally incompetent, or clumsily and viciously misleading, it is the part of good judgment to use it. Refine it, check it, train it, but do not throw away a good tool until you certainly have a better in hand. And do not forget that in much which offers itself as objective method, introspection is really involved either directly or indirectly.

Let us then bid the movement toward objective methods and objective description in psychology God-speed, but let us also counsel it to forego the excesses of youth.

EXERCISE

1. Let us take as a phenomenon to be observed the acquisition of skill at tennis. What are some of the things that introspection would reveal and that the observation of external behavior would not? What are some of the errors likely to pervade self-observation that would not be present in observations of external behavior?

5. THE PLACE OF EXPERIMENT AND MEASUREMENT IN PSYCHOLOGY

A. Experimental Psychology[1]

BY JAMES R. ANGELL

Experiment, in psychology, is essentially like experiment in any other range of science. An experiment is simply an observation made under conditions of control. The ordinary observations of nature have to be made whenever and wherever opportunity permits. Thus, if one is to study botany, one must observe the phenomena of tropical plant life in the tropics, and in zoölogy the examination of the fauna of arctic regions can only be carried on under arctic skies. To be sure, the ingenuity of modern scientists has brought it to pass that in our laboratories we are able to simulate many of the conditions of nature in such a way as to permit the experimental control of facts which, in a previous generation, could be studied only where nature herself supplied them. In any event, the essential fact in experiment is that we shall be able to produce the phenomena which we desire to study.

The advantages of this procedure are so obvious as hardly to require elaboration, and it is a matter of common knowledge that the remarkable achievements of modern science are largely due to the development of experimental methods. It is clear that if one is in a position to alter some single factor in a given situation one is enabled to judge from the consequences which follow, as compared with the consequences which are observed when this factor is allowed to operate, what its real causal significance may be. To illustrate, suppose one desires to study the effects of light upon the growth of plants. Nature herself gives us much evidence bearing on this matter, and yet in nature light seldom varies unaccompanied by changes in other physical phenomena. It is combined in an almost invariable way with the production of heat, and it frequently varies in a confusing manner with conditions of moisture. Now it is possible in the laboratory to produce a situation in which every circumstance except light shall be kept perfectly constant. Under such conditions, by supplying white, red, green, and blue lights, and by remarking the effects upon the various forms and processes of vegetation, when light is taken away or when it is allowed to play uninterruptedly upon the plant, one is in a position to determine the significance of all kinds of light for the phenomena of plant life with a certainty which would never be possible from observations of nature alone.

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[1] Taken from *Chapters from Modern Psychology*, pp. 76–79. New York: Longmans, Green & Co., 1912.

Not only is there this obvious advantage of being able to analyze out relations of cause and effect in a way which otherwise would be vastly more difficult and require vastly more time, but experimental procedure also possesses another quality, which makes it of indispensable significance for modern science. This is the possibility of *verifying* alleged observations many times over and at the hands of many different observers. From this circumstance it comes about that scientific doctrine can be much more quickly and crucially tested than was formerly the case.

Experiment in psychology has precisely the same merits and involves precisely the same kind of procedure that it does elsewhere in the natural sciences. For centuries, common sense had assumed that mental processes could not be submitted to the conditions which are essential for experiment. Indeed, only within the last three centuries has the true significance of experiment secured adequate recognition anywhere in science. It has been a common source of reproach to psychology that it could never become a true science, partly because it was alleged that it could never employ mathematics and could therefore attain no real accuracy, partly because, as has just been said, it was regarded as being outside the range of experiment. Both these assertions have been disproved conclusively.

B. Measurement in Psychology[1]

BY FRANCIS GALTON

The importance of submitting our faculties to measurement lies in the curious unconsciousness in which we are apt to live of our personal peculiarities, and which our intimate friends often fail to remark.

Even the existence of such a peculiarity as colour blindness was not suspected until the memoir of Dalton in 1794. That one person out of twenty-nine or thereabouts should be unable to distinguish a red from a green, without knowing that he had any deficiency of colour sense, and without betraying his deficiency to his friends, seems perfectly incredible to the other twenty-eight; yet as a matter of fact he rarely does either the one or the other. It is hard to convince the colour-blind of their own infirmity. I have seen curious instances of this: one was that of a person by no means unpractised in physical research, who had been himself tested in matching colours. He gave me his own version of the result, to the effect that, though he might perhaps have fallen a little short of perfection as judged by over-refined tests, his colour sense was for all practical purposes quite good. On the other hand, the operator assured me that when he had toned the intensities of a pure red and a pure green in a certain proportion. the person ceased to be able to distinguish between them! Colour blindness is often very difficult to detect, because the test hues and tints may be discriminated by other means than by the normal colour sense. Ordinary pigments are never pure, and the test colours may be distinguished by those of their adventitious hues to which the partly colour-blind man may be sensitive. We do not suspect ourselves to be yellow-blind by candle light, because we enjoy pictures in the evening nearly or perhaps quite as much as in the day time; yet we may observe that a yellow primrose laid on the white table-cloth wholly loses its colour by candle light, and becomes as white as a snowdrop.

EXERCISE

1. Suppose that you want to know whether poetry is more easily memorized when a selection is read and re-read from beginning to end until it is mastered, or when the selection is mastered by parts. Plan an experiment which will give a quantitive answer to your problem.

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[1] Adapted from *Inquiries into Human Faculty and Its Development*, pp. 45-46. London: J. M. Dent & Sons, 1883.

6. THE RELATION OF PSYCHOLOGY TO OTHER SCIENCES

A. Classification of Science[1]

BY HOWARD C. WARREN

It will help us to understand the field of psychology if we consider its relation to the other branches which are ordinarily grouped under the generic term *science*. Science means the discovery and systematic formulation of general truths of nature. The division of science into branches is more or less a matter of convenience. Nature is a single interworking system of things and events, and hence in a way all science is one. But for convenience of study we group together those phenomena which are similar in character, and we investigate them apart from the rest. Any such group is called 'a science.' For example, the properties and combinations of elements in a cell are studied in the science of *chemistry*, the play of forces in the science of *physics*, the special activities of cells in the science of *physiology*. These events usually occur at the same time and concern the same objects; but the investigator or student examines one set or class, assuming or passing over the others for the time being.

It should be emphasized also that science as such is not concerned with individual facts or events. Each event is considered as representing any number of similar events, and it is especially the *interworking* of events that interests the scientist. The observation of nature in all its phases during many centuries has shown us that nature *acts uniformly*—that given the same conditions, the same results follow. The doctrine of the 'uniformity of nature' enables us to experiment with individual things and to apply the results of these particular observations to all similar things by means of generalizations, or 'laws.'

The most fundamental division of science is into *abstract* and *concrete*. Abstract science investigates the relations which hold equally well for every kind of specific facts. The abstract sciences include *mathematics* in all its branches and *logic*. Quantitative and numerical relations apply alike to atoms, masses, forces, and living creatures. What the savage or the child discovers by counting his fingers and by adding, subtracting, and grouping them in various ways, may be applied on a large scale to the study of the stars and to tables of human mortality—in fact to all phenomena. The intelligent man forms habits of mathematical association and uses them in connection with every event of life. These habits are modes of reasoning, and when they are developed into an organized system they become a branch of science—or a group of such branches. These branches form the *abstract sciences*, or, as they are sometimes called, the *mathematical* sciences. They may also be called the *general* sciences, since they hold for all classes of natural phenomena.

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[1] Taken from *Human Psychology*, pp. 3–6. Boston: By permission from Houghton Mifflin Co., 1919. Copyrighted by Howard C. Warren.

The concrete sciences deal with phenomena which belong to *special phases* of nature. They are also often called *special sciences* or *empirical sciences*, which points to the fact that the truths of nature in each specific field are discovered by observing the actual course of events in that field, and not by taking the truths discovered in one sphere and applying them to another without question.

Formerly scientists thought it proper to carry over generalizations from one field to another in this way. It was assumed that the planets revolved in circles on account of the geometrical simplicity of the circle. Even Newton assumed that there must be seven primary colors corresponding to the seven tones of the musical scale. We find many such instances where early science carried over generalizations from one field to another instead of observing the actual course of events. This is called the *a priori* or *rational* method of investigation. At present it has been almost wholly abandoned for the *empirical* method in each of the special fields of science. The laws of abstract science are still carried over to the various concrete sciences; but this is because they have been found by repeated observation to apply universally.

The fundamental concrete sciences are *chemistry* and *physics*. Chemistry deals with the relations between specific material units; physics deals with the general relations between bodies in space and time. At present it is not clear which of these two branches is the more fundamental. Probably they are coördinate phases of nature, a fact which is expressed in the phrase "physicochemical relations."

Biology is another special branch of science, but less fundamental than physics or chemistry. It treats of phenomena which appear only in certain special groups of physicochemical units called organisms. Coördinate with biology are the branches known as *astronomy* and *geology*. All three of these branches deal with 'local' phases of nature which appear on the earth or in the universe about us; they are less general than physics and chemistry. Biology is divided for convenience into a number of branches, such as zoölogy and botany, which need not be discussed here. A more important subdivision of biology is into the three sciences of *morphology*, *physiology*, and *psychology*. Morphology deals with the structure and arrangement of the various parts and organs of living creatures; physiology deals with the internal processes of organisms; psychology with their relations to their surroundings.

A further group of sciences deal with the relations between separate organisms. These are called the *social sciences*. They are less fundamental than biology. The science of *sociology* treats of the general interaction among organisms of the same species. Human sociology is the most highly developed of these branches, because the human species displays far greater mutual interaction among its members than any other kind of organism. But other species, such as ants and bees, may be studied from the same standpoint. A branch closely related to this is *social psychology*, which examines psychological data so far as they are modified or affected by the social grouping of individuals. Other social branches are *economics*, *ethics*, *jurisprudence*, etc. (Table I.)

TABLE I

Classification of Science

1. Abstract (General)	*a*	Logic		I
	b	Mathematics		
2. Concrete (Special)	*a*	Physics		II
		Chemistry		
	b	Astronomy		
		Geology		
		Biology	i. Morphology	III
			ii. Physiology	
			iii. Psychology	
	c	Social Science	i. Sociology	IV
			ii. Social Psychology	
			iii. Ethics, etc.	

EXERCISE

1. Suggest some experience that could be studied from the standpoint of psychology and from that of sociology; of economics; of law; of ethics.

B. The Place of Psychology in the System of Sciences[1]

BY JAMES SULLY

In concluding this account of the scope or purpose of psychology we may seek to define somewhat more fully and systematically its relations to other departments of knowledge.[2]

(*a*) To begin with then, as a positive science dealing with a special group of phenomena, psychology is to be co-ordinated with the physical sciences. And if, as is commonly done, we arrange the special sciences in a scale of decreasing generality or increasing specialty and complexity, we shall place psychology at the end, after biology. Thus the main departments of science will stand as follows: Mathematics, physics, chemistry, biology, psychology.

(*b*) But, again, psychology as the theory of mind stands out from and in antithesis to the group of physical sciences. Among the phenomena of which it seeks to give an account the mental processes which make up knowing or cognition occupy a foremost place. And in this account of the process of knowing it embraces every form and variety of knowledge, the mathematician's, chemist's, and so forth, *on its subjective side*, i.e., as the activity of some particular mind or minds. In this way psychology is coextensive with and supplements the work of all the special sciences. It takes the objective facts and truths reached by the sciences and views this certified knowledge as the outcome of certain mental processes which constitute knowing.

(*c*) We may now define the relation of psychology to philosophy. As already pointed out, modern psychology has asserted a position for itself as a science by separating itself in a measure from philosophy. At the same time this separation cannot, in the nature of the case, be complete. The scientific study of mind, though capable of being carried out independently of any metaphysical suppositions as to its ultimate nature or substance, necessarily leads up to the problems of rational psychology, the substance of the soul, its immortality, and so forth. So too, while it is right and important to distinguish, as we have done, the psychology of cognition, which confines itself to giving an account of the process of knowing, from the Theory of Knowledge, which deals with the objective truth or validity of our so-called cognitions, it must be evident that the two are connected. It may be safely said indeed that a psychological study of the process of cognition is a necessary preliminary to the discussion of the problems of the nature and the criterion of true cognition.

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[1] Taken from *The Human Mind*, I, pp. 11–13. New York: D. Appleton & Co., 1892.

[2] If you are unfamiliar with the general nature of physics, philosophy, biology, or sociology, seek out someone who can discuss the matter with you, or ask a librarian to recommend some simple statement of what you want to know.—EDITORS.

Turning now to sciences which have the more distinctly practical function of guiding action, we see at once that psychology will furnish the necessary foundation for those systems of rules by which we may direct and control mental activity. If, to anticipate our exposition, we adopt the common distinction of three psychical functions—cognition, feeling, and volition—we find a regulative science corresponding to each. Thus the psychology of cognition forms the basis of the regulative science of Logic, which aims at giving us rules by which we may know that we are thinking or reasoning correctly. The psychology of the feelings underlies Aesthetics as the regulative science which seeks to determine the true objective standard of what is beautiful and worthy of admiration. Lastly, the psychology of the will connects itself with the regulative science of Ethics which aims at fixing the grounds of moral obligation and the standard of right conduct.

In addition to these comprehensive regulative sciences there are others of a more distinctly practical character, having a more narrow and special end, which are also based on psychology. Thus the whole work of education, or of aiding in the development of others' minds, is clearly grounded on a knowledge of the mental processes. And the sciences of jurisprudence, political government, and so forth, which aim at controlling or otherwise influencing other minds, have to borrow their principles from the science that supplies a general theory of the workings of the human mind.

C. The Relation of Philosophy and Psychology[1]

BY HARALD HÖFFDING

Psychology forms the basis on which the ideal mental sciences, logic and ethics, build. What is true and good can be determined only from the human standpoint, and cannot be understood without acquaintance with actual human nature. Logic and ethics set up ideals of human endeavor in thought and action. But if these ideals are to have any value in actuality, they must be rooted in it, and must therefore be based on a knowledge of the deepest and most general elements and powers of human nature. *Logic*, as the science of method, studies the special methods of investigation, and tries to trace them back to fundamental methods immediately arising from the nature of human consciousness; as the philosophical science of knowledge, it tries to lay down the general principles, and the consequent limits, of human knowledge; but without psychological insight into the development of the life of ideas, such an attempt can have no good result. *Ethics* tries to lay down general principles for the estimation of human volition and action, and to find out the direction in which, according to these principles, human life should be developed; but, in attempting this, it must always proceed from human nature as actually given, and from its possibilities as given by psychological laws. Among these possibilities ethics, after weighing them, makes its choice.

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[1] Taken from *Outlines of Psychology*, pp. 27–28. (Translated by Mary E. Loundes.) London: Macmillan & Co., 1891.

On the other hand, to confound logical and ethical ideals with psychological reality leads to the distortion of psychology. Psychology is concerned only with what *is*, not with what *should be*. Of course, that state of consciousness in which it becomes apparent to us that there is something we ought to do comes also within the province of psychology; like every other state of consciousness, it is here investigated. But psychology makes no valuation; it inquires only into the actual connection, and into the manner and the laws of its development, and leaves it to ethics to pronounce a judgment on the different states. Psychology regards mental phenomena as natural phenomena, and examines all of them with the same calmness and impartiality.

D. The Relations of Biology, Sociology, and Psychology[1]

BY GEORGE HENRY LEWES

Biology furnishes both method and data in the elucidation of the relations of the organism and the external medium; and so far as Animal Psychology is concerned this is enough. But Human Psychology has a wider reach, includes another important factor, the influence of the social medium. This is not simply an addition, like that of a new sense which is the source of new modes of Feeling; it is a factor which permeates the whole composition of the mind. All the problems become complicated by it. In relation to Nature, man is animal; in relation to Culture, he is social. As the ideal world rises above and transforms the sensible world, so Culture transforms Nature physically and morally, fashioning the forest and the swamp into garden and meadow-lands, the selfish savage into the sympathetic citizen. The organism adjusts itself to the external medium; it creates, and is in turn modified by the social medium, for Society is the product of human feelings, and its existence is *pari passu* developed with the feelings which in turn it modifies and enlarges at each stage. Obviously, then, our science must seek its data not only in Biology but in Sociology; not only in the animal functions of the organism, but in the faculties developed under social developments.

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[1] Taken from *Problems of Life and Mind* (Third Series, "Problem the First," pp. 71–72. Boston: By permission of a special arrangement with Houghton, Osgood & Co., 1879.

EXERCISES

1. Psychology, according to Sully, is less general and more complex than physics in its subject-matter. Do you think this is so? Why?
2. Why can psychology never be completely separated from philosophy? To what extent do you think that the same holds good for each of the other sciences?
3. What is meant by the claim that psychology is closely related to both biology and sociology? Suggest a problem of mind whose solution might be facilitated by a knowledge of biology, and a problem of mind whose solution might be facilitated by a knowledge of sociology.

7. APPLICATIONS OF PSYCHOLOGY

A. Value of Psychology[1]

BY ROBERT M. YERKES

Has psychology the same values as science in general?—Yes. The knowledge of psychical events which it offers us is valuable both from the point of view of the scholar and from that of the applied scientist. As physical science teaches us how to predict and prepare for or control events in the objective world, so psychology teaches us how to foresee and modify events in consciousness. Are there baneful psychological phenomena whose occurrence we should be able to anticipate and prevent, then we must look to psychology for the needed information. Psychiatry as a special branch of psychology is, indeed, concerned exclusively with the study of aspects of our mental life which demand control. Education is to a very large extent the conscious or unconscious application of psychological facts and laws. If the study of mind from the scientific point of view and by exact methods had accomplished nothing for the human race except to bring about rational medical and educational treatment of mental diseases and defects it would have doubly justified its existence. But the fact is that psychology is meeting varied demands for accurate, exhaustive, and useful knowledge of mental processes and of their conditions or causes. Apparently there is no sufficient reason for distinguishing the physical sciences from the psychical on the ground of values. Each group of sciences aims to satisfy our longing for knowledge and our need for the control of life. Both should increase human comfort and happiness. Both should tend to improve the race.

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[1] Taken from *Introduction to Psychology*, pp. 52–55. New York: Henry Holt & Co., 1911.

Psychology alone can give us self-knowledge.—We laugh sadly when any one is foolhardy or stupid enough to attempt to use electricity in utter ignorance of its properties, but even greater are the reasons for concern and pity when a human being is seen struggling through life ignorant of his psychological characteristics and possibilities. We have been taught by the hard lessons of physics that one should not attempt to deal with a locomotive or an aeroplane until he thoroughly understands its mechanism and capacities. Yet, all the experience of the ages has not sufficed to teach us the folly of using our minds in ignorance of their constitution, peculiarities, characteristics, and capacities. In spite of the fact that I am not a visualizer, I try to carry on work which demands this psychological characteristic. Ignorant or oblivious of the fact that I am defective in ability to distinguish colors, I undertake responsibilities which I can not properly fulfill. Careless of the inevitable results, if not wholly ignoant thereof, I persist in a harmful habit of thought or action until my mental development has been seriously distorted or dwarfed. In what department or phase of life are we so careless of facts and principles as in our mental life? Admitting that intimate and exact knowledge of the psychological make-up of the self is of inestimable value for success and happiness, we go forward blindly. Self-analysis, self-observation, introspection should teach us self-control. They should enable us to understand our likes and dislikes, our prejudices and prides, our peculiar strengths and weaknesses, our associations and memories, and in the light of this understanding we should rationalize our living, and especially our social relations, as would otherwise be impossible.

Psychology should help us also to understand other selves.—If knowledge of the self deserves to rank first in importance for the realization of the possibilities of the individual life, knowledge of other selves deserves to rank next. Indeed, self-knowledge is the essential condition of the understanding and appreciation of other beings. At every turn in life's pathway we are forced to adjust ourselves to the thoughts, feelings, purposes of other persons. How can this be done intelligently if we are ignorant of our own mental peculiarities? How can we sympathize with the joy or sorrow of another when we have known neither of these experiences? As well might we insist that it is possible to act intelligently with respect to strychnine in ignorance of its properties, as to maintain that we can treat our own or another's mind properly in ignorance of what the science of psychology should teach.

Systematic self-observation leads to intimately valuable knowledge of one's self, and this self-understanding enables one to understand other persons. Finally the rational comprehension of the constitution of other minds serves as a condition for sympathy. We must be able to imagine ourselves in the midst of this or that desirable or undesirable event—storm, explosion, celebration, victory, fall—in order to adjust our behavior to the situation; and in precisely the same sense we must be able to imagine the experiences of our friend in order to act appropriately or sympathetically. Few of us, however, are sufficiently close and keen observers of our own or of others' minds to be able to understand them perfectly. Psychology, like the other sciences, is far from complete. It fails to do all that we expect of it simply because of the multitudinous unsolved problems which confront it. But this should serve as a stimulus to redoubled effort in research rather than as a cause of discouragement. Believing, as we do, in the importance of scientific knowledge of consciousness, of its facts, its principles, and its causal relations, for the understanding and appreciation of the self and of other persons and for the control of psychological events, the least we can do is to insist upon the importance of more and better observation and experimentation.

B. The Contribution of Psychology to Education[1]

BY EDWARD L. THORNDIKE

To an understanding of the material of education, psychology is the chief contributor.

Psychology shares with anatomy, physiology, sociology, anthropology, history, and the other sciences that concern changes in man's bodily or mental nature the work of providing thinkers and workers in the field of education with knowledge of the material with which they work. Just as the science and art of agriculture depend upon chemistry and botany, so the art of education depends upon physiology and psychology.

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[1] Taken from "The Contribution of Psychology to Education," *Journal of Educational Psychology*, I, 6–7. Baltimore, Md.: Warwick & York, 1910.

A complete science of psychology would tell every fact about every one's intellect and character and behavior, would tell the cause of every change in human nature, would tell the result which every educational force—every act of every person that changed any other or the agent himself—would have. It would aid us to use human beings for the world's welfare with the same surety of the result that we now have when we use falling bodies or chemical elements. In proportion as we get such a science we shall become masters of our own souls as we now are masters of heat and light. Progress toward such a science is being made.

Psychology contributes to understanding of the means of education, first, because the intellects and characters of any one's parents, teachers and friends are very important means of educating him, and, second, because the influence of any other means, such as books, maps or apparatus, cannot be usefully studied apart from the human nature which they are to act upon.

Psychology contributes to knowledge of methods of teaching in three ways. First, methods may be deduced outright from the laws of human nature. For instance, we may infer from psychology that the difficulty pupils have in learning to divide by a fraction is due in large measure to the habit established by all the thousands of previous divisions which they have done or seen, the habit, that is, of "division —decrease" or "number divided—result smaller than the number." We may then devise or select such a method as will reduce this interference from the old habits to a minimum without weakening the old habits in their proper functioning.

Second, methods may be chosen from actual working experience, regardless of psychology, as a starting point. Thus it is believed that in the elementary school a class of fifteen pupils for one teacher gives better results than either a class of three or a class of thirty. Thus, also, it is believed that family life is better than institutional life in its effects upon character and enterprise. Thus, also, it is believed that in learning a foreign language the reading of simple discussions of simple topics is better than the translation of difficult literary masterpieces that treat subtle and complex topics. Even in such cases psychology may help by explaining *why* one method does succeed better and so leading the way to new insights regarding other questions not yet settled by experience.

Third, in all cases psychology, by its methods of measuring knowledge and skill may suggest means to test and verify or refute the claims of any method. For instance, there has been a failure on the part of teachers to decide from their classroom experience whether it is better to teach the spelling of a pair of homonyms together or apart in time. But all that is required to decide the question for any given pair is for enough teachers to use both methods with enough different classes, keeping everything else except the method constant, and to measure the errors in spelling the words thereafter in the two cases. Psychology, which teaches us how to measure changes in human nature teaches us how to decide just what the results of any method of teaching are.

EXERCISES

1. Describe a concrete situation in which it would be desirable to make a careful study of another's characteristics.
2. Describe how some of your hobbies affect your thinking and behavior in fields apparently unrelated to those hobbies.
3. Point out some of the contributions a wide and thorough knowledge of human nature could make to an advertising man.

CHAPTER II

SOME GENERAL FEATURES OF NERVE ACTION

1. THE EVOLUTION OF THE NERVOUS SYSTEM[1]

BY GEORGE HOWARD PARKER

THE NERVOUS ORGANIZATION OF SEA-ANEMONES

To gain some idea of the evolutionary steps by which the nervous system of man has been arrived at, it is plainly necessary to examine the types of nervous organization found among the lowest of the multicellular animals. As a good example of these lowly organisms the sea-anemones may be selected. Sea-anemones are sac-like animals attached to rocks or stones, and provided with a single aperture which leads from the exterior into their large central cavity in which digestion goes on and from which the undigested residue is discharged to the exterior through the single aperture already mentioned which serves thus both as mouth and anus. This aperture in almost all sea-anemones is surrounded by one or more circles of tentacles.

When an expanded sea-anemone is stimulated by being touched or otherwise excited to action, it commonly responds by a quick general contraction, whereby the sea water contained in its digestive cavity is discharged through its mouth and the whole volume of the animal is greatly reduced. This general contraction may be called forth from almost any point on the surface of the animal, showing that the muscles that lie within the walls of the creature and are responsible for the contraction, are collectively accessible to nervous impulses from almost every point on the surface. This accessibility is insured through the presence of a nerve-net which spreads throughout the living substance of the animal and which brings its surface into connection with almost its whole musculature. This nerve-net nowhere shows a special concentration but extends rather uniformly throughout the body and thus affords an easy path over which impulses may spread from the surface of the animal to its musculature. A nervous system of this type is commonly called a diffuse nervous system as contrasted with a centralized one and is characterized by the absence of a central organ,[1] or adjustor, through which all impulses must pass on their way from the receptors to the effectors.

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[1] Adapted from *The Evolution of Man*, chap iii, pp. 86–94. New Haven: Yale University Press, 1922.

The characteristics by which a diffuse nervous system may be distinguished from a centralized one are well shown in a number of activities exhibited by sea-anemones. When small fragments of meat or other bits of food are placed on the tentacles of a sea-anemone, these organs wind around the bits of food and, by bending in the appropriate direction, deliver them to the mouth. If, now, a distending tentacle on a quiet and expanded sea-anemone is suddenly seized at its base by forceps, cut off and held in position so that its original relations to the animal as a whole can be kept clearly in mind, the tentacle will still be found to respond to food brought in contact with it and will eventually turn toward that side which was originally toward the mouth. Thus the tentacle has within itself a complete neuromuscular mechanism for its own responses and it is unnecessary that it should be connected with any general nervous center in order to carry out its characteristic movements. Its share of the diffuse nervous system is sufficient for its own needs. How different this type of organization is as compared with the centralized type is seen when we contrast the activity of the tentacle with that of the

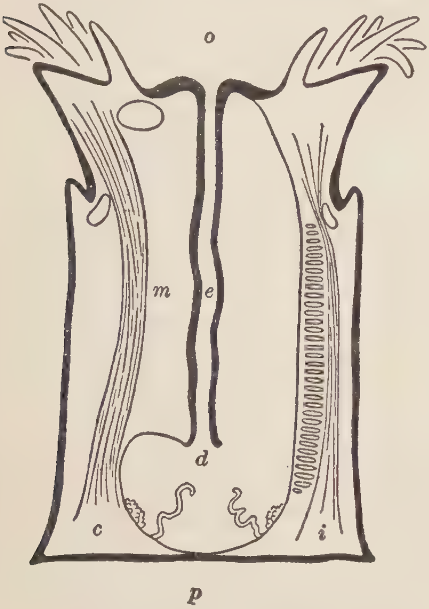

FIG. 1.—Diagram of a longitudinal section of the sea-anemone *Metridium;* the area of attachment is the pedal disc *p;* in the middle of the oral disc *o* is the mouth leading into the oesophagus *e* which opens into the digestive cavity *d*. The oesophagus is held in place by the mesenteries *m* when complete *c*, the incomplete mesenteries *i* failing to reach this tube. From Parker, *The Elementary Nervous System*, by courtesy of Lippincott.

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[1] In higher forms the brain and spinal cord are the chief nerve centers or adjustors. The sense organs are spoken of as receptors, because they receive stimuli, and the muscles and glands as effectors because they effect action (see next selection).—EDITORS.

leg of a dog or the claw of a lobster when severed from the animal's body. These parts when thus cut off are quite incapable of coördinated movement and show no evidence whatever of the type of response that characterizes them as a part of the whole organism.

Another activity of the sea-anemone that illustrates the nature of the diffuse nervous system is creeping. This operation is accomplished by the so-called pedal disc, that portion of the animal by which it attaches itself to the substrate. By means of muscular waves that pass across this disc the sea-anemone may creep slowly like a snail from spot to spot. If a sea-anemone is cut crosswise in two and the upper half of the animal carrying the mouth and tentacles is thus removed, the lower half with the pedal disc intact will pucker up the wounded surface and soon creep about with as much success as the whole animal did. Here again the part concerned carries within its own bounds a neuromuscular mechanism complete for its needs.

Again if a sea-anemone is fed from one side of its mouth, it will take in by means of the tentacles on that side one fragment of food after another. If, now bits of meat be alternated with bits of filter paper soaked in meat juice, the two materials will be accepted indiscriminately for some eight or ten trials after which only the meat will be taken and the filter paper will be discharged into the sea water without being brought to the mouth. If, after having developed this state of affairs on one side of the mouth, the experiment is now transferred to the opposite side, both the filter paper and the meat will again be taken in till this side has also been brought to a state of discriminating. Thus the experience of one part of the animal has no perceptible influence on another in the sense that there is no common nervous center where the experience of a given part may be put to the service of the rest. It is as though we had to burn each finger in turn before we discover that fire is bad for the hand. These examples bring into strong contrast the types of reaction characteristic of the higher and the lower multicellular animals and serve to illustrate the difference between the centralized and the diffuse nervous system.

In a diffuse nervous system, such as that possessed by a sea-anemone, the external surfaces of the animal serve as receptors and these communicate directly with the subjacent musculature. The nerve-net serves to spread the impulses throughout the body without involving any central organ. Thus the sea-anemone may be said to possess receptors and effectors without an adjustor or central nervous organ properly so called. This central organ is, therefore, a feature of the higher animals and in comparison with receptors and effectors it must be looked upon as a more recent evolutionary acquisition. Our sense organs did not develop in consequence of a central nervous system but our central nervous organs developed because our very early ancestors had already acquired receptors and muscles.

If lowly organized animals, such as sea-anemones, possess nothing worthy of the name of a central nervous organ, it follows that their so-called sense organs must differ considerably in function from those of the higher animals. In highly differentiated types the sense organs, the eye, the ear, the organs of touch, of taste, and of smell, are concerned with supplying the central apparatus with those elements out of which the intellectual life is built. This function must be entirely superfluous in such an animal as a sea-anemone where no central organ exists. Here the sense organs are not concerned with sensations; they merely excite muscles to action, a function which they also exercise in the higher animals. They are receptors for a multitude of external changes and when thus excited they serve as triggers, so to speak, to set off the subjacent muscles. Since they are not concerned with sensations they are more appropriately designated as receptors than as sense organs and hence the term receptor, which is the more inclusive of the two, is the better one to employ. Sea-anemones, therefore, represent a more primitive type of neuromuscular mechanism than the higher animals do, one in which of the three organs, receptor, adjustor, and effector, only the first and last are present, the adjustor, or central organ, being a later acquisition.

SPONGES

If receptors and effectors were developed before adjustors, it is natural to ask whether of these two parts one preceded the other or did they both evolve simultaneously? Among the multicellular animals lower than the sea-anemones, the sponges throw light on this question. A single sponge is a goblet-shaped or finger-shaped animal attached to the sea-bed. Its outer surface is covered with pores which lead into a system of canals provided with lash-cells by which the water is removed through the canals to a large space in the middle of the sponge from which this fluid escapes by a conspicuous opening at the unattached end. From the current of water thus passing through the sponge the animal extracts its nourishment and the production and control of this current is one of its essential activities.

Many sponges, like the ordinary bath sponge, are colonial animals and consist of a number of sponge individuals more or less fused together. In the bath sponge, which in its commercial form is represented merely by its horny skeleton, the number of individuals can be judged by the number of very large openings that penetrate from the outside to its interior. These are usually four, five, or more in number and represent the outlets for the water currents in the living sponge. In quite a number of the colonial sponges the component individuals are much more separated than in the bath sponge and rise from a common base as so many separate fingers. Such fingered sponges are very convenient for study and are commonly of such a size as to admit of easy experimental treatment.

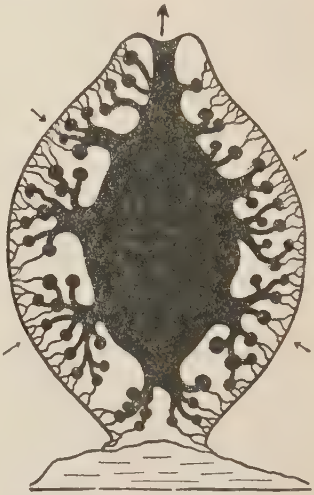


FIG. 2.—Diagram of the canal system of a calcareous sponge (modified Haeckel). The innumerable superficial pores receive water from the exterior, as shown by the arrows on the sides; the osculum at the apex discharges water to the exterior. From Parker, *The Elementary Nervous System*, by courtesy of Lippincott.

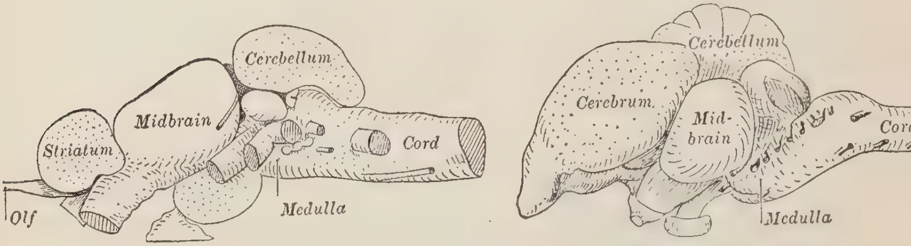
Sponges are for the most part extremely inert and aside from a slight contraction and consequent bending of the body as a whole they show very few activities except the opening and closing of their pores and other apertures. In this way sponges control their water currents and they accomplish this partly by the formation of protoplasmic membranes by which the pores are closed and partly by the action of rings of simple muscle cells that surround the pores, especially the outlet openings.

The control of a given outlet cannot be accomplished from an adjacent finger nor can it be brought about by stimulating the finger at the end of which the outlet lies except when the stimulus is directed to the immediate neighborhood of the outlet itself. In fact there is not only no experimental evidence to show that one finger is connected nervously with another, but there is no reason to suppose that parts of the same finger are thus connected. In other words, nervous transmission, such as is abundantly seen in sea-anemones, seems to be completely absent from sponges. When this fact is coupled with the inability of histologists to discover any trace of nervous tissue in sponges, it seems safe to conclude that these animals are devoid of nervous elements and that their muscles are set in operation by direct stimulation rather than by anything that may be described as a nervous impulse. From this standpoint, therefore, sponges may be regarded as animals provided with muscles but devoid of nervous tissue. They possess effectors but no receptors and their condition suggests that in the evolution of the neuromuscular mechanism, muscle appeared first and nervous tissue later, developing probably in close proximity to the previously formed muscle as a device for exciting the muscle to action.

If this conclusion is true, the evolution of the neuromuscular system must have begun with the appearance of muscle as an independent effector, after which receptors, or nervous elements to serve as triggers for setting off the muscles, were added. Finally, between the receptors and the effectors a central nervous organ, or adjustor, grew up as the third element and thus completed the neuromuscular system as exemplified in the higher animals. So important has this central organ become in the life of these animals that we scarcely realize that it is the latest addition to our nervous equipment and yet such seems to be the case. In its first appearance it must have been chiefly an organ of transmission and intercommunication, a specialized outgrowth of the more diffuse nerve-net. Later it doubtless took on the function of modifying the animal's responses in relation to its past and thus became a storehouse of experience and the seat of the intellectual life. As such it has reached its highest point of development in the vertebrates where as the brain of man it is without doubt the most remarkable structure ever evolved.

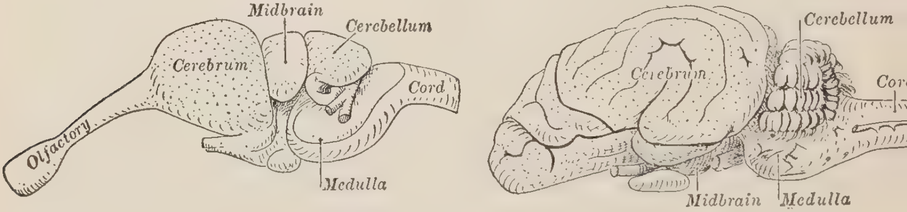
THE NERVOUS SYSTEM IN VERTEBRATES

The central nervous organ of the vertebrate, using this term in the most limited sense, consists of the spinal cord and the brain. The spinal cord throughout the vertebrate series is a relatively uniform structure, but the brain exhibits a strikingly progressive development. This is seen especially in two of its parts, the cerebellum and the cerebral hemispheres. Both, but particularly the cerebral hemispheres, grow immensely in size and complication as we proceed from the fishes to man. In the lower vertebrates the cerebral hemispheres are concerned almost entirely with the sense of smell and their cortex, or outer covering, is spoken of as the olfactory cortex, or archipallium. In the mammals, however, the hemispheres have reflected upon them, in addition to olfaction, practically all the sensory activities of the body as well as the mechanism for the voluntary control of the musculature. These added parts constitute the neopallium which shoves the olfactory archipallium into the background. Thus the neopallium comes to be the great central organ of the higher animals. It receives almost the whole of the sensory inflow; it stores the impressions of the past; and from it emanate those impulses that excite what we call our volitions.


Cerebellum
Midbrain
Striatum
Cord
Medulla
Olf
Cerebellum
Cerebrum
Mid-brain
Cor
Medulla

A. Brain of codfish

C. Brain of dove


Midbrain
Cerebellum
Cerebrum
Cord
Olfactory
Medulla
Cerebellum
Cerebrum
Cor
Midbrain
Medulla

B. Brain of alligator (Crosby)

D. Brain of dog

Fig. 3.—Plate showing successive stages in the evolution of the vertebrate nervous system (especially conspicuous is the increase in size and importance of the indirect centers, the cerebellum and cerebrum). From Judd.

It is a remarkable fact that in man the cerebral cortex consists of layers of nerve cells so regularly arranged that a rough estimate of their number may be made. This is believed to be approximately 9,200,000,000. This prodigious number of cells is estimated to weigh a little over thirteen grams and to occupy the space of less than a cubic inch. When it is remembered that every human being develops from an egg cell of approximately one fifth of a millimeter in diameter and that this cell begins growth by dividing into two, and these two each into two thus making four, and then into eight, sixteen, thirty-two, and so forth, it will be seen what a stupendous process development is even from the standpoint of simple numbers, for from this one egg cell by division must come not simply the nine billion and more cells of the cortex, but all the other countless billions of cells that go to make up the rest of the body. Nor is this process of cell multiplication, prodigious as its results show it to be, the only remarkable feature in development, for it is also equally striking that when the requisite number of cells have been produced, the operation of cell division stops. At least this is true of the cortex, for here, as in a few other parts of the body, the neurones change very little in number after birth. The brain cells with which the babe is born last for the most part without renewal through mature life to old age and death. What brings the operation of cell multiplication to an end at the appropriate moment is as little understood by embryologists as is the exciting cause of the initial increase.

When it is recalled that the 9,200,000,000 cells in the human cerebral cortex are the nervous elements of this organ and that they collectively constitute rather less than a cubic inch of protoplasm, it seems almost incredible that they should serve us as they do. They are the materials whose activities represent all human mental states, sensations, memories, volitions, emotions, affections, the highest flights of poetry, the most profound thoughts of philosophy, the most far-reaching theories of science, and, when their action goes astray, the ravings of insanity. It is this small amount of protoplasm in each of us that our whole educational system is concerned with training and that serves us through a lifetime in the growth of personality.

EXERCISE

1. Complex forms of behavior and experience are dependent upon the existence of a complex nervous system. To what extent and why are they also dependent upon a multiplicity of sense organs and muscles?

2. ESSENTIAL FEATURES OF NEURAL ACTIVITY[1]

BY KNIGHT DUNLAP

The function of every nerve cell with the important exception of one class (receptors), is of precisely the same kind as the function of every other nerve cell in the body, viz.: *to be irritated or stimulated, and to irritate in turn another cell.* This is a statement which sums up the situation as far as present observations go.

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[1] Taken from *Mysticism, Freudianism and Scientific Psychology*, pp. 130–31. St. Louis: C. V. Mosby Co., 1920.

The nerve cell may receive the stimulation (1) from a primary source: it may be irritated by light, or air vibration, or pressure (as on the skin), or by chemicals, such as sugar or citric acid. In these cases, where the source of the irritation is a physical stimulus, the nerve cell is called a *receptor*.[1]

Or (2), the cell may be irritated by another neuron. Thus, the receptor, having been irritated by a physical stimulus irritates in turn a nerve cell in contact with it, and this second cell in turn irritates a third.

The irritation, conversely, may be passed on either (1) to another nerve cell, or (2) to muscle or gland cells. The irritation of these *effectors*, as muscle and gland cells are called, is the ultimate object of the process, and these effectors perform, in contraction or secretion, the work which adjusts the animal body as a whole, to the environment which supplies the stimuli.

EXERCISE

1. Discuss the proposition that muscular movement or glandular secretion is the ultimate object of nervous activity.

3. THE NATURE OF NERVE CELLS

A. Neurons[2]

BY H. NEWELL MARTIN, REVISED BY ERNEST G. MARTIN

Neurons.—The nervous system as a whole is made up of structures called neurons, each of which seems to be a single nerve-cell.

A typical neuron consists of a *cell-body* containing a nucleus and from whose surface project many rather short branching processes called *dendrites*, and a single long process having few if any branches and known as the *axon* (Fig. 5). Neurons which convey impulses to muscles (*motor neurons*) have this structure (Fig. 6A). The only branching of a motor neuron is at its very end, where it is distributed to the muscle fibers of which it has control. The number of muscle fibers thus innervated by one motor neuron varies in different muscles, ranging from a half dozen to fifty or more.

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[1] While the statement is made for nerve cells only, it applies also to certain epithelial cells which have the nerve cell function. Only in the class of receptors are such quasi-neural epithelial cells found, and only in a few senses: certainly in the auditory and gustatory.

[2] Adapted from *The Human Body* (10th ed.), pp. 136–37. (Revised by Ernest G Martin.) New York: Henry Holt & Co., 1919.

The neurons which convey impulses from sensory regions to the center (*sensory neurons*) have a structure which appears at first view, to be altogether different from that of the typical neuron just described. They have cell-bodies with nuclei but instead of a single axon and

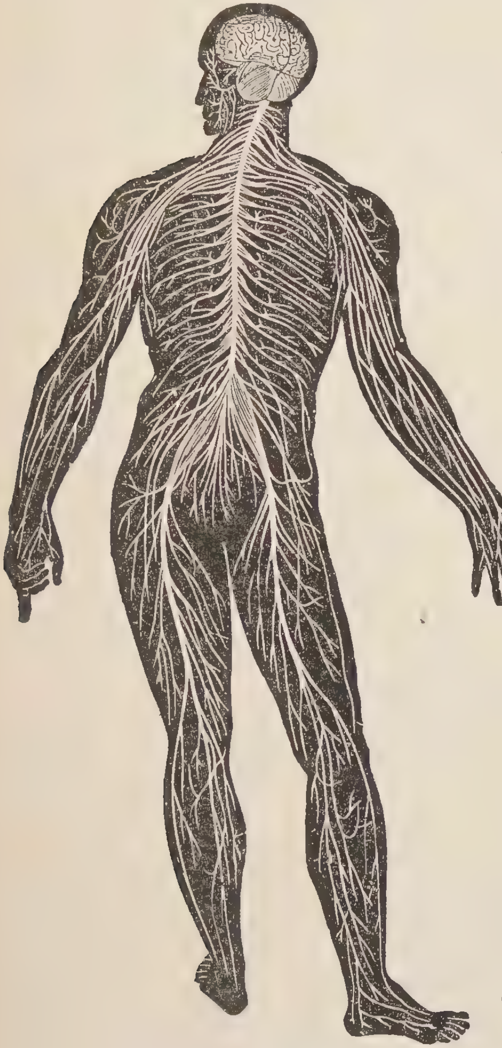

FIG. 4.—Diagram illustrating the general arrangement of the nervous system.

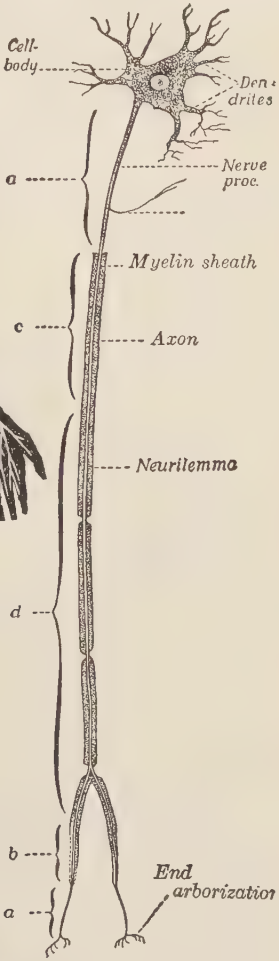
Cell-body
Den-drites
a
Nerve proc.
Myelin sheath
c
Axon
Neurilemma
d
b
End arborization
a

FIG. 5.—Diagram of neuron (*Stöhr.*)

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numerous much-branched dendrites the cell-body gives rise to two long axon-like processes, one connecting with the receptor and the other having a number of branches. The *bipolar* character of these neurons, moreover, is concealed in many through the union of the two processes for a short distance from the cell-body, giving an appearance as though the latter were on a side branch of a long axon (Fig. 6B). The underlying similiarity of these to the type neuron appears if we consider that the dendrites of the typical neuron are replaced in the sensory neuron by the axon-like process which connects with the receptor.

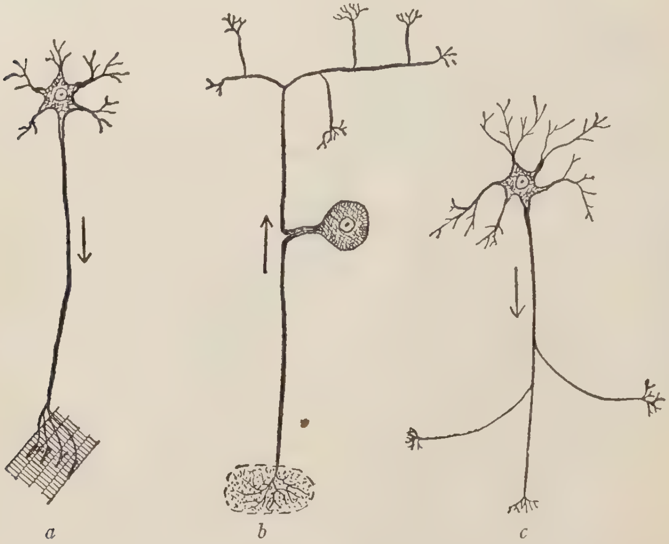

FIG. 6.—Types of neurons. *a*, motor; *b*, sensory; *c*, association

A third sort of neuron occurring in the Body resembles the first or motor type in the possession of cell-body and many branching dendrites. Instead of long, slightly branched axons, however, neurons of this sort have short and very much-branched ones. These neurons occur interposed in the pathway of impulses from sensory to motor neurons and are often called *association* neurons (Fig. 6C): they are not, however, the only sort of association neurons; many neurons which belong physiologically to the group of association neurons in that they form communicating paths between sensory and motor neurons are anatomically of the type to which all motor neurons belong.

The nervous system as a whole is made up of neurons of these three types. The sensory neurons, as stated above, lead from the receptors to the center; motor neurons lead from the center to the active tissues; and association neurons form the connecting links wherever such are necessary. All sensory neurons communicate with other neurons at their central terminations. Since the central axons are branched (see above) each sensory neuron has a number of such connections. All motor neurons have likewise connections with other neurons at their central ends. Association neurons connect with other neurons at both ends, as they must if they are to serve as links in a chain whose ends are sensory and motor neurons.

B. The Size of Neurons[1]

BY WALTER S. HUNTER

Beginning students often get the impression that neurons are always microscopic in size, a condition that is frequently true. All are microscopic in diameter, but many of them are several feet in length. One neuron, for example, extends from the top of the brain to the lower part of the spinal cord in the small of the back. Again one neuron may extend from the cord to the tip of the toe. The cell-bodies themselves range in size from 1/160 to 1/6,000 of an inch in diameter; the axones, from 1/2,000 to 1/100,000 of an inch in diameter. As many as 100,000 of these latter may be bound together like a cable with connective tissue to form a *nerve*.

EXERCISE

1. What relations can you see between the shapes of the different types of neurons and their different functions? Why, for instance, are long processes more necessary for *sensory* and *motor* than for association neurons?

4. THE NERVE IMPULSE

A. The Nature of the Nerve Impulse[2]

BY C. JUDSON HERRICK

The specific nervous functions involve the consumption of living substance, both in the cell body and in the nerve-fibers. This is in part an oxidation process, and this phase of the activity can be roughly measured by the amount of carbon dioxid eliminated. Until very recently it was not possible to secure any evidence of CO_2 production in nerve-fibers; in view of this and of the further fact that nerve-fibers seem to be less susceptible to fatigue than nerve-cells and synapses, many physiologists assumed that nervous conduction is not a chemical process, but perhaps some sort of molecular vibration. The conduction of a nervous impulse through a living nerve-fiber is accompanied by an electric change, the so-called negative variation, or action current, which by some physiologists has been identified with the nervous impulse itself. This and other complicated theories of nervous transmission assume that the process is essentially a physical change (probably of an electric nature) which involves no chemical alterations, no consumption of material, no metabolism.

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[1] Adapted from *General Psychology*, pp. 133–34. Chicago: University of Chicago Press, 1919.

[2] Taken from *An Introduction to Neurology* (2d ed.), pp. 102–4. Philadelphia: W. B. Saunders Co., 1918.

But by means of recently devised apparatus of extreme delicacy Tashiro has shown very clearly and quantitatively that the resting nerve-fiber eliminates CO_2 and that during functional activity caused by stimulation the amount of CO_2 is increased to about double that of the resting nerve. The same investigator subsequently showed that the amount of CO_2 given off by nerve-fibers is quite as great per unit of weight as that given off by the nerve-cell bodies of the ganglia. Tashiro has shown, moreover, that the rate of CO_2 production is greater in that portion of a nerve-fiber which lies nearer to the source of the stimulus than in a similar portion of the same nerve-fiber farther from the receptive end and nearer to the discharging end. This applies to both sensory and motor fibers. Child has confirmed this by showing that different parts of the nerve-fiber show differences in susceptibility to certain poisons corresponding to the differences in rate of oxidation of their substance. There is, accordingly, a physiological gradient in the nerve-fiber, the physiological activity diminishing in the direction of the normal conduction of the nervous impulse. The neuron is thus seen to have an intrinsic physiological polarity of its own quite apart from that occasioned by the irreversible character of the synapse.

It is, therefore, probable that the transmission of a nervous impulse involves a wave of chemical change throughout the length of the nerve-fiber, though a change of a quite different character from that occurring in the cell body during its functional activity. That the nervous conduction is not a simple electric discharge through a free conductor, nor any other sort of simple ethereal or molecular vibratory wave motion, is evident from the fact that its velocity of propagation through the nerve-fiber, which is easily measured, is slower than any known wave movement of this character.

In the unmyelinated[1] nerves of vertebrates the rate of progression of the nerve impulse varies from 0.2 to 8 meters per second; in the myelinated sciatic nerve of the frog it varies from 24 to 38 meters per second; and in human myelinated nerves it may be as rapid as 125 meters per second. This rate of conduction of the nervous impulse in peripheral nerves varies greatly with different animals, with different nerves in the same animal, and in the same nerve under different physiological conditions.

B. The Doctrine of Specific Nerve Energies[2]

BY WILLIAM H. HOWELL

Whether or not the nerve impulses in various nerve fibers differ in kind is a question of great interest in physiology. The usually accepted view is that they are identical in character in all fibers and vary only in intensity. According to this view, a sensory nerve—the auditory nerve, for instance—carries impulses similar in character to those passing along a motor nerve, and the reason that in one case we get a sensation of hearing and in the other a contraction of a muscle is found in the manner of ending of the nerve, one terminating in a special part of the cortex of the cerebrum, the other in a muscle. From this standpoint the nerve fibers may be compared to electrical wires. The current conducted by the wires is similar in all cases, but may give rise to very different effects according to the way in which the wires terminate, whether in an explosive mixture, an arc light, or solutions of electrolytes of various kinds. We have in physiology what is known as the doctrine of specific nerve energies, first formulated by Johannes Müller. This doctrine expresses the fact that nerve fibers when stimulated give only one kind of reaction, whether motor or sensory, no matter in what way they may be stimulated. The optic nerve, for instance, gives us a sensation of light, usually because light waves fall on the retina and thus stimulate the optic nerve. But if we apply other forms of stimulation to the nerve they will also, if effective, give a sensation of light. Cutting the optic nerve or stimulating it with electrical currents gives visual sensations. On the identity theory of the nerve impulses the specific energies of the various nerves—that is, the fact that each gives only one kind of response—is referred entirely to the characteristics of the tissue in which the fibers end. If, as has been said, one could sucessfully attach the optic nerve to the ear and the auditory nerve to the retina then we should see the thunder and hear the lightning.

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[1] Myelin is a fatty sheath covering certain nerve processes. Unmyelinated nerves, of course, are nerves lacking this sheath.—EDITORS.

[2] Taken from *A Text-Book of Physiology* (7th ed.), pp. 121–23. Philadelphia: W. B. Saunders Co., 1918.

The alternative theory supposes that nerve impulses are not identical in different fibers, but vary in quality as well as intensity, and that the specific energies of the various fibers depend in part at least on the character of the impulses that they transmit. On this theory one might speak of visual impulses in the optic nerves as something different in kind from the auditory impulses in the auditory fibers. With our present methods of investigation the question is one that can not be definitely decided by experimental investigation; most of the discussion turns upon the applicability of the doctrine to the explanation of various conscious reactions of the sensory nerves.

So far as experimental work has been carried out on efferent nerves, it is undoubtedly in favor of the identity theory. The action current is similar in all nerves examined; the reactions to artificial stimuli are essentially similar. Moreover, nerves of one kind may be sutured to nerves of another kind, and, after regeneration has taken place, the reactions are found to be determined solely by the place of ending.

EXERCISES

1. (*a*) What is the chief importance of knowing whether active nerves produce CO_2? (*b*) Of knowing the velocity of the nerve impulse?
2. What bearing has the phenomenon commonly called "seeing stars" upon the doctrine of specific nerve energies?

5. CONNECTIONS BETWEEN NEURONS

A. Definition of the Synapse[1]

BY PERCY GOLDTHWAIT STILES

A term which it is most important to understand is *synapse*. A synapse is said to exist wherever the branching processes of a nerve-cell transmit stimulating energy to the processes of a second nerve-cell. If there is no continuity between the two, the synapse is a place of contact or of close approach. If the adjacent units of the gray matter are really bound together, the synapse is the region of the finest subdivision of the protoplasmic bonds between them. If we speak physiologically, the synapse is a functional junction; it is not absolutely necessary to decide whether it is an anatomic junction. One doctrine implicitly held with reference to the synapse is that transmission across it can take place in only one direction. The property involved has been spoken of as a "valve-action" (Fig. 7).

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[1] Adapted from *The Nervous System and Its Conservation* (2d ed.), pp. 28–29. (Revised.) Philadelphia: W. B. Saunders Co., 1917.

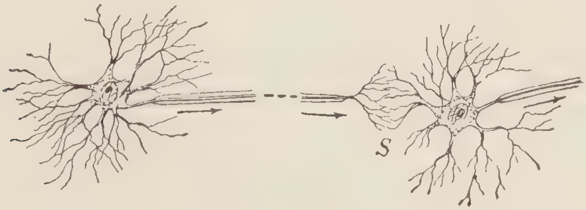

FIG. 7.—To illustrate a synapse (S), which is the functional junction between the terminal arborizations—*i.e.*, fine branchings—of the left-hand neuron and certain dendrites of the one to the right. Effects are secured only in the direction of the arrows.

B. Facts Established about the Synapse[1]

BY C. JUDSON HERRICK

The following important points regarding the synapse seem to be established:

1. Unimpeded protoplasmic continuity across the synapse has not been clearly established, and in some cases there is clearly a membranous barrier interposed between the two neurons. But the exact nature of this barrier is unknown and it by no means follows that the synaptic membrane is an inert substance. It may be composed of living substance of a different nature from that of the other protoplasm of the neurons.

2. The transmission of the nervous impulse across the synapse involves a delay greater than that found in the nerve-fiber or the cell body. This suggests that there is some sort of an obstruction here which does not occur within the length of the neuron.

3. The synapse is more susceptible to certain toxic substances, such as nicotin, than is any other part of the nerve.

4. Though a nerve-fiber seems to be capable of transmitting an impulse in either direction, the nervous impulse can pass the synapse

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[1] Adapted from *An Introduction to Neurology* (2d ed.), p. 57. Philadelphia: W. B. Saunders Co., 1918.

in only one direction, viz., the direction of normal discharge from the axon of one neuron to the dendrite of another. The synapse, therefore, acts as a sort of valve.

5. Observations upon injured neurons show that the degenerations caused by the severance of their fibrous processes or by the destruction of the cell bodies from which the fibers arise cannot cross the barriers interposed by the synapses.

EXERCISE

1. It is sometimes held that the formation of new habits consists in changing the pathways followed by nerve impulses. If this is so, what is indicated or suggested by the facts about the synapse enumerated by Herrick?

6. CONTINUITY OF NERVE ACTION[1]

BY WILLIAM MC DOUGALL

Among the most striking of physiological discoveries are those relating to the reflex actions of the spinal cord. It has been shown that, when the brain of certain animals has been destroyed, while the spinal cord and the trunk and limbs and their nervous connexions with the spinal cord remain intact, the limbs may still be excited by appropriate stimulation of the skin to execute movements that seem to be intelligently directed. Thus, if a drop of weak acid is put on the skin of the trunk of a frog whose brain has been destroyed, the hind-foot that can best reach the spot is raised and drawn across it, as though with the purpose of removing the irritation; and, if that foot is held fast, the other hind-foot makes a similar "attempt." Or if to the skin of the back of a dog in a similar condition an irritation somewhat similar to the bite of a flea is applied, one hind-foot will be raised towards the spot and will execute rapid scratching movements, and, though these movements are not so accurately adjusted as the similar movements of an intact animal, they are yet "aimed" with some precision at the spot irritated.

Now such reflex movements seem to be completely determined by a chain of purely physiological processes. In each case we seem to be able to trace the progress of a wave of physical change, initiated by the stimulus in the sense-organ of the skin, up the sensory nerves into the spinal cord, along certain nervous channels in the cord and out along the motor nerves that pass to the muscles whose contractions bring about the movements. There seems to be no scope for the intervention of mind as a directing agency. The whole process, from beginning to end, seems to be physically determined by the molecular structure of the nerves and by the mode of inter-connexion of sensory and motor nerves within the spinal cord, which determines that the excitement transmitted by the sensory nerves shall pass over to this or that group of motor nerves. This conclusion is borne out by the fact that similar reflex movements may be excited in our own bodies while we are in deep sleep or during the complete unconsciousness produced by such drugs as chloroform and ether. The spinal cord, in so far as it is not made up of bundles of nerves passing to and from the brain, has been shown to consist wholly of such complex connexions between sensory and motor nerves constituting nervous mechanisms for the production of reflex movements.[1] And it has been shown also that the structure of the whole brain is essentially similar to that of the spinal cord, that it seems to consist of nervous mechanisms of great complexity serving to transmit nervous impulses, physical excitations, from the sensory nerves to the motor nerves.

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[1] Taken from *Physiological Psychology* ("The Temple Primers") pp. 5–7. London: J. M. Dent & Co., 1908.

This recently-acquired knowledge of the nervous system thus forbids us to accept the view that was for a long time generally entertained, the view that the impulses of the sensory nerves came to an end at some spot or spots in the brain where they stimulate the soul to produce sensations, while the impulses of the motor nerves are initiated in their central ends in the brain by the soul playing upon them as a musician plays on the keys of a piano. We are compelled to believe rather that the nervous processes of the brain are of the type of the reflex processes of the spinal cord, and consist in the transmission of physical impulses through channels of great complexity from the sensory to, or towards, the motor nerves, and to believe also that all psychical processes are accompanied by nervous processes of this character.

EXERCISE

1. Enumerate some acts commonly performed by you and show how each depends upon the sense organs, the nervous system, and the muscles.

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[1] Other changes, such as the secretion of tears and saliva, are also produced in this way, but it is allowable to include all these under the term "movement."

CHAPTER III

STRUCTURES OF THE NERVOUS SYSTEM

1. THE DEVELOPMENT OF THE NERVOUS SYSTEM IN THE INDIVIDUAL ORGANISM[1]

BY KNIGHT DUNLAP

Nervous tissue develops from the ectoderm, (the outermost layer of cells). At an early stage in the development of the embryo, after it has elongated, a dorsal longitudinal groove, the medullary groove (or neural groove) [Fig. 8], forms, and the edges of this groove soon come together, forming the medullary tube (neural tube) [Fig. 9].

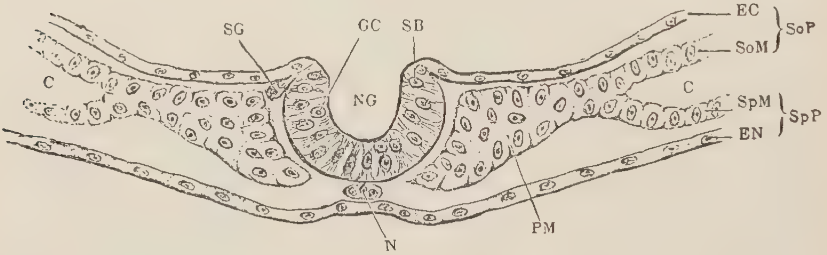

FIG. 8.—Transverse section of ferret embryo, showing medullary (neural) groove. (Cunningham, *Anatomy.*) *EC*, ectoderm; *EN*, endoderm; *GC*, germinal cell; *N*, notochord; *NG*, neural groove; *PM*, paraxial mesoderm; *SpM*, splanchnic mesoderm; *SoM*, somatic mesoderm; *SB*, spongioblast; *SG*, spinal ganglion.

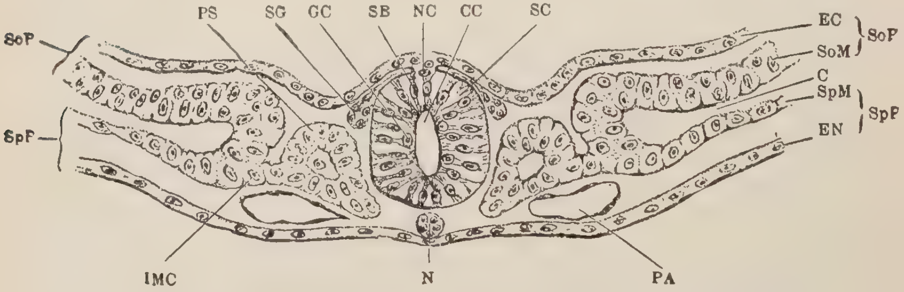

FIG. 9.—Transverse section of ferret embryo of greater age than shown in Fig. 8, showing medullary canal. (Cunningham, *Anatomy.*) *NC*, neural crest; *CC*, central canal; *SG*, spinal ganglia.

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[1] Adapted from *An Outline of Psychobiology* (2d ed.), pp. 42–44. Baltimore: Johns Hopkins Press, 1917.

The walls of the anterior part of this tube become later very thick, forming the brain [Fig. 10]; with relatively small cavities, the ventricles, representing the original cavity of this part of the tube. The walls of the posterior part of the tube thicken to a less degree, but more uniformly, forming the spinal cord, with a small central canal.

As the medullary tube forms, some cells pass outwardly from the posterior portion to form the spinal ganglia. At an early period, not definitely determined, other cells migrate from the growing spinal cord (or possibly from the spinal ganglia), to form the sympathetic ganglia, and other visceral ganglia, more remote from the spinal ganglia. From the anterior part of the medullary tube there is a migration of those cells which become the neurons in the retina of the eye and those which become the ganglion cells in the cochlea of the ear. Possibly also the olfactory receptors originate in this way.

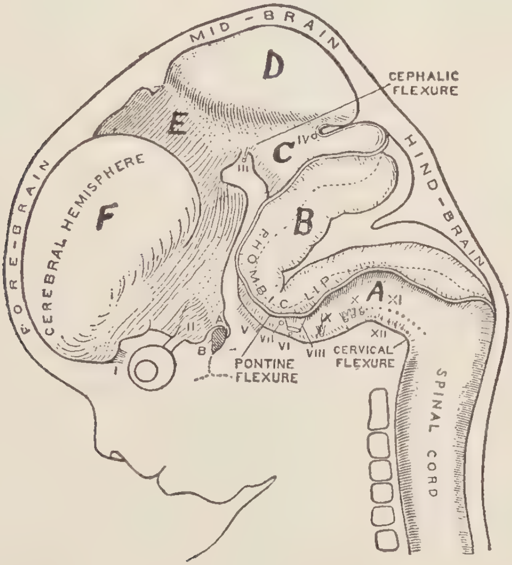
MID-BRAIN
D
CEPHALIC FLEXURE
E
IV
C
III
HIND-BRAIN
CEREBRAL HEMISPHERE
F
FORE-BRAIN
B
RHOMBIC LIP
A
X
XI
IX
XII
II
A
B
I
V
VII
VI
VIII
PONTINE FLEXURE
CERVICAL FLEXURE
SPINAL CORD

FIG. 10.—Profile view of the brain of a human embryo of six weeks. (Modified from Cunningham, after His.) *A*, myelencephalon; *B*, metencephalon; *C*, isthmus; *D*, mesencephalon; *E*, diencephalon; *F*, telencephalon.

From the brain, spinal cord, spinal ganglia, and visceral ganglia, the nerve cells send processes (nerve fibers) to the various tissues of the body. After complete development these are axons of efferent neurons, and dendrites of afferent neurons.

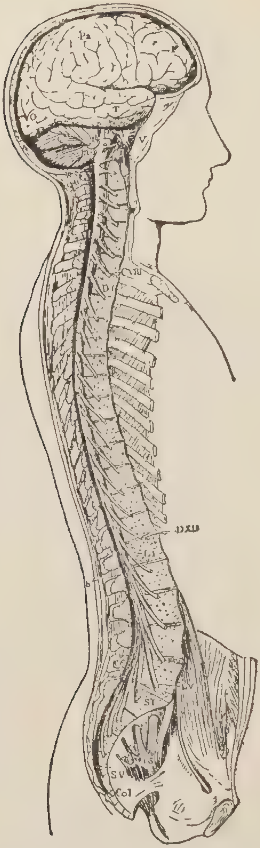

FIG. 11.—Cerebro-spinal axis, reduced to $\frac{1}{8}$ diameter. (After Bougery.) A longitudinal section through the median plane of the spinal column, and in part of the skull; leaving in relief the brain, cord, and spinal nerve roots. Lobes of the cerebrum: *Pd*, parietal; *F*, frontal; *O*, occipital; *T*, temporal [compare Fig. 15]; *C*, cerebellum; *mo*, medulla oblongata; *CI–CVIII*, cervical nerves; *DI–DXII*, thoracic nerves (formerly known as dorsal nerves); *LI–LV*, lumbar nerves; *SI–SV*, sacral nerves; *Co*, coccygeal nerve; *ms*, *ms*, upper and lower extremities of the spinal cord.

EXERCISE

1. Can you see any reason why the nervous system, a mechanism for the processes of adjustment, should develop out of the outermost layer of cells of the organism?

2. BRAIN AND SPINAL CORD[1]

BY PERCY GOLDTHWAIT STILES

It has been possible to proceed to this point with only the most general statement of the spatial arrangement of the parts which are united to form the nervous system. A certain amount of detail must now be supplied. It will be helpful to make some comparisons between what is to be seen in the simpler vertebrates and what is found in man.

Let us attend to the outlines of the nervous mechanism as exemplified in the frog, an animal which has been chosen for very many of the cardinal researches upon this system. Here, as always, we recognize an axial or central portion and the nerves extending from it to all parts of the body. The axial portion is said to consist of the brain and the spinal cord. The brain is lodged in the cavity of the skull; the cord extends through a canal made by the successive arches of the vertebrae, the individual bones of the spinal column. Those nerves which take their rise from the brain are called *cranial*, the reference being to the *cranium*, which is the portion of the skull bounding the brain. The nerves originating from the cord are called *spinal*. The cranial nerves issue from the skull. The spinal nerves find their way through notches between adjacent vertebrae. The number of both the cranial and the spinal nerves is smaller in the frog than in many of the higher forms, including man.

The spinal nerves emerge in pairs which are symmetrically developed. A single member, right or left, in one of these pairs is found to be united with the cord by two *roots*. These are best referred to as dorsal and ventral, the former being nearer the skin of the back and the latter at a greater depth. The relations referred to are best understood when presented in a diagram (Fig. 12).

The regular fashion in which the spinal nerves part into dorsal and ventral roots might well suggest a difference in function corresponding to the anatomic separation. It has, in fact, been known for about a hundred years that the dorsal roots are almost wholly composed of afferent[2] fibers and the ventral roots even more dominantly of those which are efferent.[3] The statement of this contrast in function between the roots of the two sets is known as Bell's law. The cranial nerves do not part in this orderly way into dorsal and ventral divisions where they join the substance of the brain; moreover, they are extremely unequal in size. Some are found to be composed of afferent fibers, some of efferent, and some of both together.

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[1] Adapted from *The Nervous System and Its Conservation* (2d ed.), pp. 60–71 (Revised.) Philadelphia and London: W. B. Saunders Co., 1917.

[2] Sensory—conducting toward central nervous system.—EDITORS.

[3] Motor—conducting toward muscles or glands.—EDITORS.

A cross-section of the spinal cord brings to view several features which may be described later, but at the moment only one of these will be mentioned. This is the minute *central canal*, a reminder that the central nervous system is to be regarded as tubular in its fundamental organization, though the walls of the primitive tube have encroached upon its cavity until the remaining space is very small compared with the masses of white and gray matter surrounding it. The slender central canal of the cord leads forward to a much more conspicuous series of chambers in the brain. We can now outline the anatomy of this superior portion of the system as it is seen in the frog.

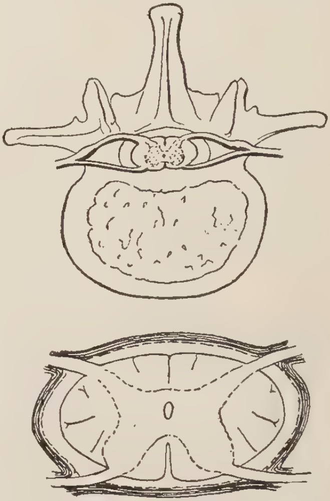

FIG. 12.—The upper figure shows the spinal cord within the arch of a vertebra. A pair of spinal nerves is shown, each nerve having a dorsal and a ventral root.

In the lower figure the heavy inclosure is the dura mater, the dotted line just within is in the position of the arachnoid, and then comes the space filled by the cerebrospinal fluid. The outline of the cord itself corresponds with the pia mater.

Following the spinal cord to the most anterior vertebra we find that it is here continuous with the tapering hind end of the brain, the *medulla*, or bulb. The line of demarcation between brain and cord is assumed to lie between the back edge of the skull and the first vertebra; there is no sudden change in the appearance of the nervous axis itself at this place. If the overlying bone is removed the several divisions of the brain will appear somewhat as in Fig. 13. The medulla widens from its hinder to its forward limit.

Forward of the medulla are found the two large, ovoid bodies which, with the corresponding ventral structures, are conveniently covered by the term *midbrain*. A channel extends from the fourth ventricle through this region to the cavities still farther forward; it is picturesquely named the aqueduct of Sylvius. We shall find the midbrain to be relatively much less prominent in the higher forms than in the frog.

In front of the midbrain we find in the case of the frog that by far the larger part of what remains is the *cerebrum* or the *cerebral hemispheres*. We yet distinguish, however, a limited portion of the brain between these paired structures and directly before the midbrain as the *diencephalon*.

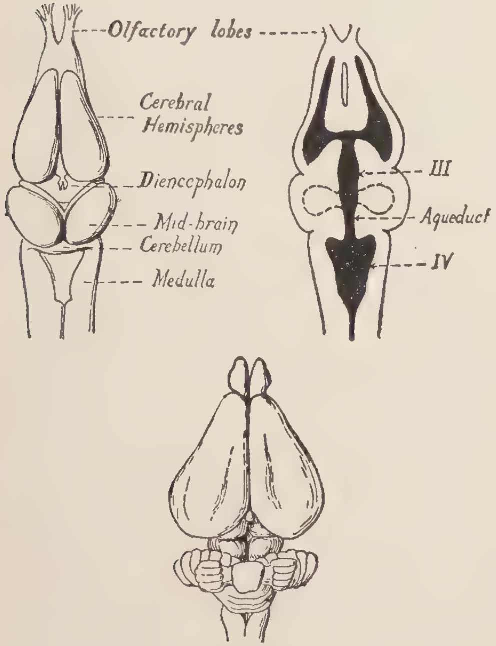

FIG. 13.—Above, the frog's brain is shown in its dorsal aspect and, within a similar outline, its cavities. The two lateral ventricles are not numbered. The cavities extending into the optic lobes are not made black because they are not characteristic of higher forms.

Below is the brain of the rabbit (dorsal view), to show how the midbrain is nearly concealed by the large cerebrum and cerebellum. (The scale of this drawing is much smaller than that used for the frog.)

At the extreme anterior end each of the hemispheres is prolonged into a brush-like development of nerve-fibers which comes into relation with the nasal lining on the same side. These extensions are usually termed the *olfactory nerves* and are counted as the first in the cranial series. No other nerves come into direct connection with the cerebrum; even the *optic nerves*, which are so much more important in determining the reactions of the more intelligent animals, join the parts just behind the hemispheres and affect them only after the impulses have been relayed or forwarded. The optic nerves are second in the series as we count from before backward. Other cranial nerves emerge at short intervals behind the optic.

All the divisions which have been described as having places in the organization of the brain of the frog can be recognized in the brains of the higher vertebrates. Their proportionate development we shall find to vary widely from what has been pictured. There is one region only hinted at in the brain of the frog which comes to be a large feature in many cases. This is the *cerebellum*. Its position in the frog is indicated by a slight dorsal growth near the medulla.

We shall now find it helpful to compare with the brain of the frog that of the rabbit, which will show a state of things intermediate between what has been described above and the human condition which must be outlined presently. If we ignore differences of absolute scale we shall see at a glance that the cerebral hemispheres in the rabbit are more massive than in the frog. We shall see also that the cerebellum has become a part of the brain only less conspicuous than the hemispheres themselves. We can still discover between the cerebellum and the cerebrum the surface of the midbrain, but this section which was so prominent in the frog has become much less so. It is evident that a moderate additional increase in the bulk of the cerebrum and cerebellum would bring these two in contact and conceal the midbrain from view. Incidentally it may be noted that in the rabbit the dorsal aspect of the midbrain is scored by a cross-fissure, so that instead of the two lobes found in the frog there is a fourfold arrangement. On this account the region in question is known as the *corpora quadrigemina.*

A change in our point of view from dorsal to lateral[1] will make it easier to grasp the result of the progressive development of the cerebrum and the cerebellum. The figure will show how the midbrain is covered in the process and will suggest at the same time how the cerebrum rolls forward over the olfactory nerves, and how the cerebellum extends backward. In cats and dogs a stage is reached at which no glimpse of the midbrain can be had without forcibly separating the overlying parts.

To understand the ordering of the various divisions in the brain of man it is first of all necessary to appreciate this preponderance of the cerebrum and the cerebellum over the remaining portions. But there is another condition which enters in to complicate the interpretation. This is a bending of the axis upon which the brain may be conceived to be built up. In the frog a line drawn from the nose through the brain and back to the end of the spinal cord will be nearly straight. In the rabbit it is still true that the organization can be referred to an axis which is substantially straight. It is very plain that the attempt to project a corresponding line from the human nose through the brain and down the full length of the cord will yield a curve suggestive of a fish-hook (Fig. 14).

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[1] Figure 14 upper drawing.

This bending of the axis is developed in connection with the carriage of the head which is appropriate to the erect position. The lower animals generally travel along the line of their spinal columns. Man moves in a line perpendicular to his spine; that is to say, he walks and gazes horizontally while his vertebral axis is kept vertical. The nervous system must be accommodated to this state of things. The bend in its axis is well indicated by an outline of the cavities in the human brain and cord. The aqueduct of Sylvius is inclined ventrally from the line of the central canal of the cord, and the lateral ventricles in the cerebral hemispheres are extended approximately at right angles to this canal. The olfactory outgrowths are also found to be in a plane perpendicular to the course of the cord.

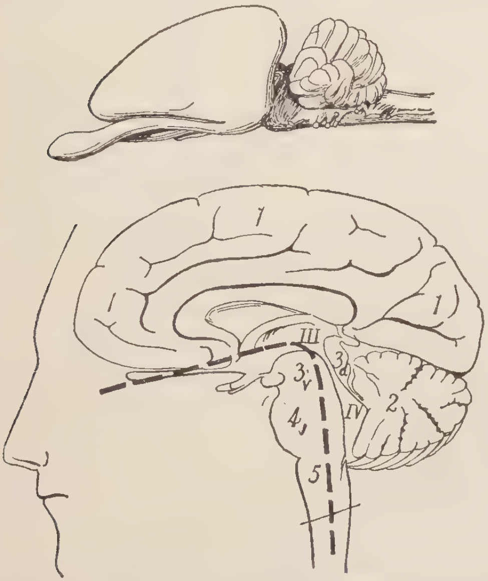

FIG. 14.—Above is the rabbit's brain from the left; below, the human brain in vertical fore-and-aft section, also viewed from the left. The bent axis is introduced in the lower figure.

1, Cerebrum; 2, cerebellum; 3, midbrain; *3d*, corpora quadrigemina, *3v*, crura cerebri, 4, pons; 5, medulla; *III*, third ventricle, which is flanked by the diencephalon; *IV*, fourth ventricle.

If, now, we make allowance for the two conditions indicated—the overwhelming growth of the cerebrum and cerebellum and the rather sharp crook in the axis—we shall find it easy to see that, after all, the sequence of the divisions in man is the same as in the frog. It is true in both cases that the medulla is the prolongation of the cord within the skull. In both, the fourth ventricle practically breaks through the "roof" or dorsal surface of the medulla, but in man it is overhung by the cerebellum. In both types the aqueduct of Sylvius leads through the region known as the midbrain and widens into a third ventricle reckoned as the cavity of the diencephalon.

In the brains of the higher animals there is a ventral feature hardly indicated in the frog, but developed, generally speaking, in proportion to the prominence of the cerebellum. This is the pons (pons varolii), a structure which presents the appearance of an outgrowth from the cerebellum clasping the medulla near its anterior border. Of course, this does not correctly describe the actual connections of the region referred to, though it is true that it contains many transverse fibers which pass into the cerebellum. It is to be noted that the cerebellum is distinctly dorsal in position to the main axis of the central nervous system. It may thus be said not to lie upon the direct course of the ascending and descending impulses which enter and leave the cranial cavity. So it is possible, for experimental purposes, to remove the cerebellum and leave this chief highway still open for service.

The removal of the cerebellum, with the object of observing the deficiencies which follow and so drawing inferences in regard to its previous activity, is permissible. But the physiologist cannot excise the midbrain or the medulla for any such purpose, since he would lose not only the influence of the part withdrawn, but would check the passage of impulses to and from regions anterior to the seat of operation. The destruction of the medulla would leave no line of communication between the cerebral hemispheres and the trunk.

The human cerebrum consists of two hemispheres, between which there is a very deep longitudinal fissure. The separation of the two halves is so marked that one thinks of the walnut kernel with its comparatively slender isthmus. The comparison is faulty, however, in that the cerebral hemispheres have more than one bond of union. Their principal tie is to be found at the bottom of the longitudinal fissure, and when cut it appears in section as a white arch. It is the corpus callosum, a structure to which the physiologists of the seventeenth century ascribed much importance. Several minor connections are observed lower down.

In all the higher animals the surface of the cerebrum is much scored by fissures. These are called *sulci*, and the convex ridges between them are spoken of as *gyri* or convolutions. Such a type of organization evidently provides for a much more extensive area of cortex than would exist otherwise. Since cortical development stands in some relation to the intelligence and general rank of the animal in the scale of being, one is disposed to look for an especially marked wrinkling in the case of man. The human brain is, indeed, much more fissured than that of the rabbit, but it is not much more so than that of the cow. The attempt to make a great deal of this feature yields but little comfort (Fig. 15).

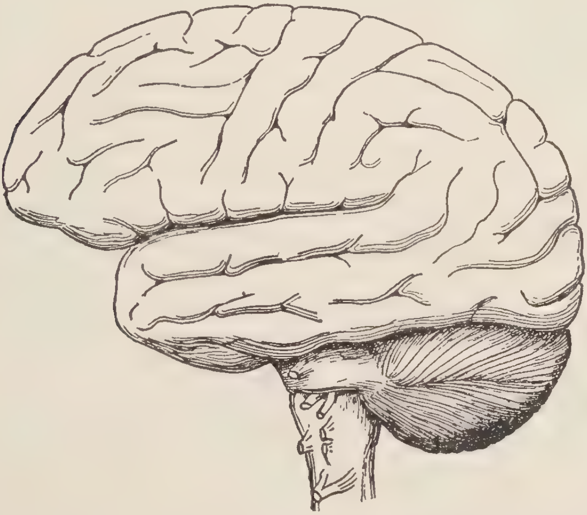

FIG. 15.—The human brain from the left. The main mass is the left cerebral hemisphere. The cerebellum, with its narrow convolutions, is below and behind. The medulla bears the stumps of several cranial nerves.

Regions of the surface of the cerebrum are usually denoted by employing the names of those cranial bones which overlie them. Thus we speak of the frontal, the parietal, the temporal, and the occipital regions or lobes. The word "lobe," often used with reference to these organs, is, perhaps, somewhat misleading. It suggests a degree of isolation more marked than that which actually obtains. The temporal portion deserves this designation more clearly than do the others, since it is quite distinct—set off by a cleft of exceptional depth, the fissure of Sylvius. On first glancing at a figure of the cerebrum one recognizes which direction is anterior by the presence of the temporal lobe, pointing downward and forward (Fig. 15).

EXERCISE

1. Practice until you can draw from memory: (*a*) a cross-section of the spinal cord with its motor and sensory connections; (*b*) a diagram showing the relative locations of spinal cord, medulla, cerebellum, pons, corpora quadragemina, cerebrum, corpus callosum; (*c*) a side view of the cerebrum showing the temporal, frontal, parietal, and occipital lobes.

3. THE AUTONOMIC NERVOUS SYSTEM[1]

BY PERCY GOLDTHWAIT STILES

The Autonomic System.—This term is used to distinguish that part of the efferent nervous system transmitting impulses from the central axis to the heart, the glands, and the smooth muscle of the entire body. The name autonomic is nearly equivalent to "self-acting" and is used to emphasize the contrast which exists between these mechanisms and the skeletal muscles—the latter being more definitely under our control. Autonomic pathways lead away from the central system at every level from the third cranial nerve to the most posterior portion of the cord.

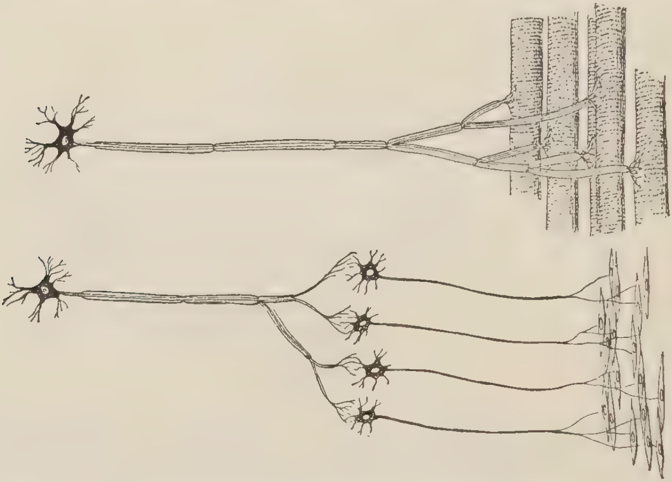

FIG. 16.—Above is shown the typic motor neuron extending from the central nervous system to the fibers of skeletal muscle. Below is the autonomic type of path. The neuron which leaves the central nervous system does not span the whole interval but ends in synaptic union with ganglion cells. These in turn send axons to the tissue controlled—in this case smooth muscle.

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[1] Taken from *Human Physiology*, pp. 118–20. Philadelphia and London: W. B. Saunders Co., 1916.

We have seen that the paths from the brain and cord to the skeletal muscles are represented by continuous fibers spanning the interval. In the autonomic system the case is otherwise. Fibers which issue from the brain and cord, bearing impulses destined to take effect in structures other than skeletal muscles, do not actually extend to these terminal stations. They end by synapses against nerve cells of a second order which in their turn control the effectors in question. These distributing neurons usually have their cell-bodies in various ganglia which are found in many localities. The fibers which run from the central nervous system to the way-stations are called *pre-ganglionic*, those which relay the impulses to the end-organs are called *post-ganglionic*. It appears to be the rule that one pre-ganglionic neuron stands in relation to a number of those of the dependent rank. It seems to follow that impulses sent from the brain and the cord to the ganglia are there multiplied and diffused. There can hardly be the precise localizing of effect obtainable in the command of skeletal muscles.

The pre-ganglionic fibers proceeding from the spinal cord are for the most part connected with ganglia which are placed in two long chains to the right and left of the spinal column at the back of the body cavity. These two chains of ganglia with their associated axons have been known as the *sympathetic system*. The term is an odd one and is not to be given any tinge of the psychologic significance naturally coupled with it.

The functions of the automatic system may be summarized under three divisions: First we have those of the head or cranial section. Fibers originating here produce effects in many organs of the trunk as well as in the head. They can bring about contraction of the pupil, increase of curvature of the crystalline lens, changes in the circulation in the glands and skin of the head, secretion of saliva, and slowing of the heart. They also contract the bronchial tubes, cause the secretion of gastric juice, and reinforce the muscular activity of most of the alimentary canal.

The second (thoracico-lumbar) division comprises all the autonomic paths leading from the spinal cord excepting a small group at its lower end. They serve to promote the contraction of most of the blood-vessels, are capable of suspending the activity of the alimentary canal, cause secretion of sweat, erection of the hairs (or goose-flesh in the human subject), dilation of the pupil, and a special activity of the adrenal bodies. . . . . They accelerate the heart.

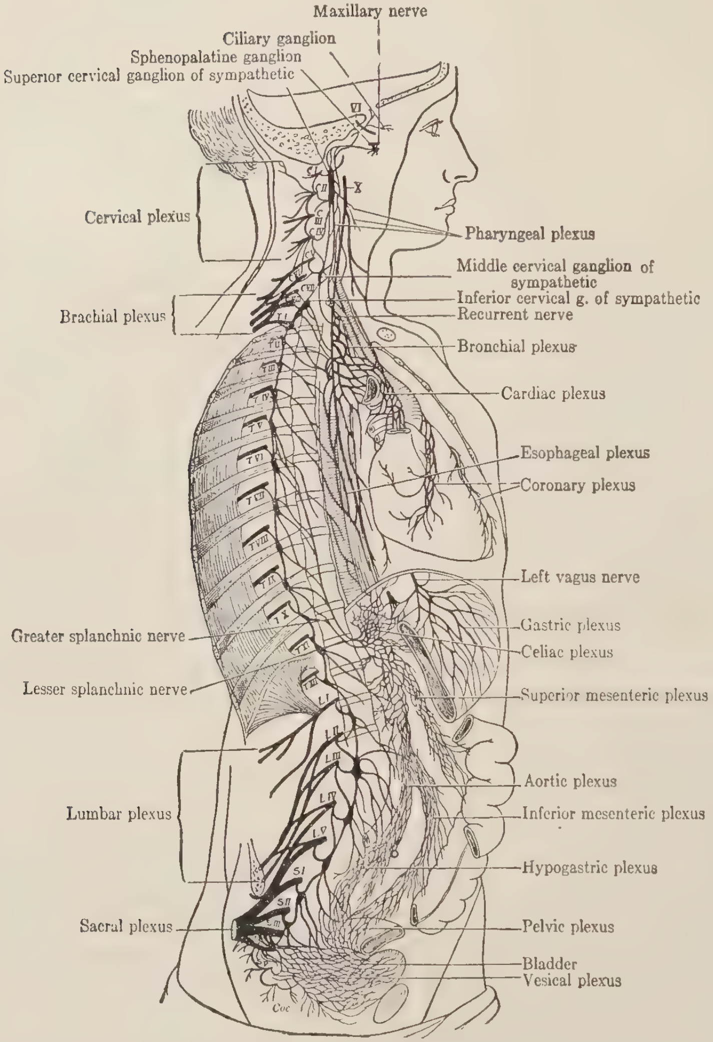
Maxillary nerve
Ciliary ganglion
Sphenopalatine ganglion
Superior cervical ganglion of sympathetic
VI
X
Cervical plexus
Pharyngeal plexus
Middle cervical ganglion of sympathetic
Inferior cervical g. of sympathetic
Brachial plexus
Recurrent nerve
Bronchial plexus
Cardiac plexus
Esophageal plexus
Coronary plexus
Left vagus nerve
Gastric plexus
Greater splanchnic nerve
Celiac plexus
Lesser splanchnic nerve
Superior mesenteric plexus
Aortic plexus
Lumbar plexus
Inferior mesenteric plexus
Hypogastric plexus
Sacral plexus
Pelvic plexus
Bladder
Vesical plexus
Coc

FIG. 17.—The sympathetic nervous system, showing the right sympathetic trunk and its relation with the spinal nerves and with the sympathetic plexuses. The Roman numerals refer to the spinal nerves. The VIth and Xth cranial nerves are also indicated. After Schwalbe from Herrick.

In the case of this organ, the alimentary tract, and the iris they definitely oppose the cranial autonomic.

The small group of paths remaining below (sacral autonomic) play upon the rectum, bladder, and reproductive organs.

EXERCISE

1. Explain in terms of the autonomic nervous system how brain activities may have an effect upon such things as appetite and heart beat.

4. ACTION OF DIFFERENT PARTS OF THE NERVOUS SYSTEM

A. The Levels of Nerve Action[1]

BY THEODORE HOUGH AND WILLIAM T. SEDGWICK

Whenever through accident, disease, or otherwise, some portion of the nervous system is destroyed, functions dependent upon it are no longer performed, or at least are not performed normally. A very large number of observations have been made upon both animals and men in this condition, and these have made it possible for us to obtain some idea of the part played in normal life by each part of the brain and cord. We shall attempt here to sketch only a few of the more important outlines of the picture, which the reader may complete by more extensive study of physiology and psychology.

We shall choose for study the case of a single animal, the frog, the anatomical structure of whose brain has been given in this chapter. The phenomena shown by the frog are, however, as far as we shall describe them, in general true of higher vertebrate animals.

We shall therefore study (*a*) the behavior of a frog whose brain has been destroyed, that is, a frog which possesses no part of its central nervous system except the spinal cord; (*b*) the behavior of a frog with spinal cord and bulb[2] intact, but destitute of midbrain and cerebrum; (*c*) the behavior of a frog with spinal cord, bulb, and midbrain, but destitute of the cerebrum.

The behavior of these incomplete animals will each be compared with that of a normal frog, which, of course, possesses a complete nervous system.

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[1] Adapted from *The Human Mechanism*, pp. 269–74. Boston: Ginn & Co., 1918.

[2] Medulla.—EDITORS.

a) The behavior of a brainless frog; that is, a frog which possesses of its nervous system only the spinal cord. Such a frog can carry out only reflex actions of a comparatively simple character. It lies flat upon its belly and, like the normal frog, bends its hind legs under its flank, but does not sit erect by supporting the head and upper trunk on the fore legs. There are no respiratory movements; the vasoconstrictor tone of the blood vessels is impaired or absent, as are also many other of the most important reflexes.

But if one leg be pulled gently backward, the animal will bend it again to its normal position under the body. If the toe be pinched, the leg will suddenly be drawn away; and if the skin of the flank be irritated by a bit of filter paper moistened with acid, the paper will be kicked off by the leg of the same side.

These are all purposeful[1] and coördinated actions, and make upon the inexperienced observer the impression that the frog is aware of the stimulus and acts intelligently. But the mere fact an act is purposeful and coördinated does not show that it is a conscious act; our movements of respiration, winking, coughing, and sneezing are purposeful and coördinated, but we know well enough that they, as well as more complicated actions, may and often do occur in the complete absence of consciousness. One of the first lessons that the student of animal behavior must learn is not to make the mistake of regarding an action as conscious merely because "it looks so" or is purposeful and more or less highly coördinated.

The spinal cord alone, then, and without the help of the brain, is capable of maintaining a small part of the normal posture of the resting frog and also of executing some of the simple reflexes, especially those involving movements of the hind legs, but it does not seem to be capable of originating actions or of doing any except reflex actions.

b) The behavior of a frog with spinal cord and bulb only. In this case there is no new feature in the maintenance of posture; the frog lies on its belly and executes the same reflexes as before. The respiratory movements, however, go on in a normal manner; the vasomotor tone of the arteries is maintained, most vasomotor reflexes may be produced with ease, and the heart may be reflexly inhibited. As compared with the brainless frog, the number of actions which the animal can execute is increased, and the reflex movements become somewhat more complicated; but the differences are slight as compared with those seen in the animal which has the midbrain in addition to the hindbrain and cord.

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[1] The word "purposeful" as used here does not include conscious purpose in its meaning. We shall see that conscious purpose involves the coöperation of the cerebrum.

c) The behavior of a frog with spinal cord, bulb, and midbrain, that is to say, a frog with the entire nervous system exclusive of the forebrain, or cerebrum. The following points are especially noteworthy: (1) the sitting posture maintained at rest; (2) balancing movements; and (3) more complicated movements of locomotion.

1) Such a frog, unlike those already described, *sits erect* exactly like a normal frog; and this fact shows that complete maintenance of the normal posture requires the coöperation of higher portions of the nervous system than the bulb and spinal cord, but does not involve the coöperation of the cerebrum.

2) If the frog be placed on a rectangular block of wood, and the block slowly turned so that the frog tends to slip off backwards, it will crawl up and over the descending edge, keeping itself perfectly balanced. By continuing to turn the block the frog can be made to creep around it almost indefinitely. Thus it not only maintains the erect position but also *corrects loss of equilibrium* by appropriate balancing movements.

3) If the frog be stroked upon its belly, it will croak; if its lips be touched with a blunt pin, it will brush the pin away with its forefoot. Most important of all, if it be thrown into the water, it will swim; and when it reaches a solid object it will crawl out upon it and come to rest. In short, the animal will carry out almost any movement of which a normal frog is capable, *provided the proper stimulus is applied;* but without this it will do nothing, though capable of doing so much.

The facts thus far brought forward show that the neurones of the mid and hind brains and of the spinal cord constitute nervous mechanisms which can maintain the normal posture, correct loss of balance, and even carry out the usual acts of locomotion. The more of the nervous system which the animal retains, the more complicated are the movements, as we should expect when we remember the increase in the number of neurones and the greater complexity of coördination thereby rendered possible.

d) Comparison with the normal frog. The behavior of a frog lacking only the forebrain, or cerebrum, differs from that of a normal frog in two most significant respects. In the first place, the animal rarely makes any movement without obvious external stimulation; if protected from drying, it will often sit motionless for days, or even weeks. Such is not the conduct of an animal which is aware of what is going on around it or of its own sensations or feelings, that is, of a conscious animal. In the second place, the frog shows the most remarkable regularity and persistency in making repeatedly the same response to the same stimulus; if its lips be touched thirty times with a blunt needle, it will brush at the offending object every time in the same way with the same forefoot. We should certainly not expect a conscious animal to do this; for, after trying one plan of action a few times, it would realize that its efforts were unavailing, and would try something else, such as jumping away. This same peculiarity is met with in all animals deprived of the cerebrum. They act like mere complicated and faithful machines; they do not act as if they were thoughtful, original, or wise.

B. The Functions of the Cerebral Cortex

I[1]

BY JAMES DUNLOP LICKLEY

Of all portions of the brain the cerebral cortex[2] possesses the most direct interest to the psychologist. In it the afferent and efferent arms of the long reflex pathways, which represent the highest type of reflex arcs, meet, and in it also many sensations are mediated. Further it is the region where the complex nervous processes which find expression in the highest forms of psychical activity take place.

From the manner in which the nervous system has gradually progressed to its great complexity in the higher animals, it is obvious that different portions of it are specialised for different functions. This general localisation was all that was known to the older physiologists, who recognised that the spinal cord presided over the execution of movements, that the cerebellum was concerned in their co-ordination, and that in the upper parts of the brain voluntary movements were initiated.

It is only since 1870 that direct proof of the functional differences between different areas of the cerebral cortex has been advanced. The first result of this work led to the belief that the cortex could be mapped out into small areas anatomically independent of one another and differing in physiological function. Later experiments and observations have shown that although there are marked differences of function between individual parts of the cortex, yet every part of the cortex is so intimately connected with every other portion that such independence is only relative. In other words interference with one part will produce effects in several other regions. This applies even to such widely different functions as sensation and motion, for in the cortex the neurons of these are so intimately associated that an insensible transition from one to the other is affected.

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[1] Adapted by permission from *The Nervous System*, pp. 81–87. New York: Longmans, Green & Co., 1919.

[2] The cerebral cortex is the outer layer of cerebral hemispheres.—EDITORS

Three methods have given valuable results in the study of cortical localisation: (1) Physiological; (2) Histological; (3) Clinical.

1) *Physiological.*—The first convincing experiments performed in animals were those of stimulation of different areas of the cortex. The cortex was exposed by removal of a portion of the skull, and stimulated electrically. By this method a region was demarcated, stimulation of portions of which evoked definite muscular movements, and the presence of a motor area was thus established.

Previous to this the chief mode of experimenting was by removing or destroying portions of the cortex, and then after a time carefully examining the voluntary muscular paralyses or interferences with sensation which followed. By a combination of the two methods greater accuracy has been ensured.

In a third series of experiments, portions remote from the cortex were destroyed, and the resulting changes (if any) in the cortex noted.

2) *Histological.*—The older method of histological investigation is an observation of the different periods at which the white fibres running to and from known areas of the cortex acquire their medullary[1] sheaths.

While it had been known for some time that the types of cells and their arrangement in layers were not exactly alike in all the regions of the cortex, yet it is only within the last few years that careful systematic observations have been made to determine whether these differences had any definite relation to cortical localisation. It has now been shown that such a relationship does exist; certain areas can be accurately differentiated by microscopic examination of their characteristics, but the proof of their functions necessarily rests on the other methods. Much has yet to be done in this direction.

3) *Clinical.*—In man, and to a lesser extent in animals, important information has been gained by studying the effects of known injuries and diseases of the brain. Destruction of the cerebral cortex may be due to external injuries, to abnormal growths, or frequently to the

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[1] A fatty sheath covering certain nerve processes.—EDITORS.

rupture of blood vessels within the skull, and in such cases the amount of injury can be determined roughly by naked-eye inspection; in a crude manner motor and sensory areas may be thus delimited. In

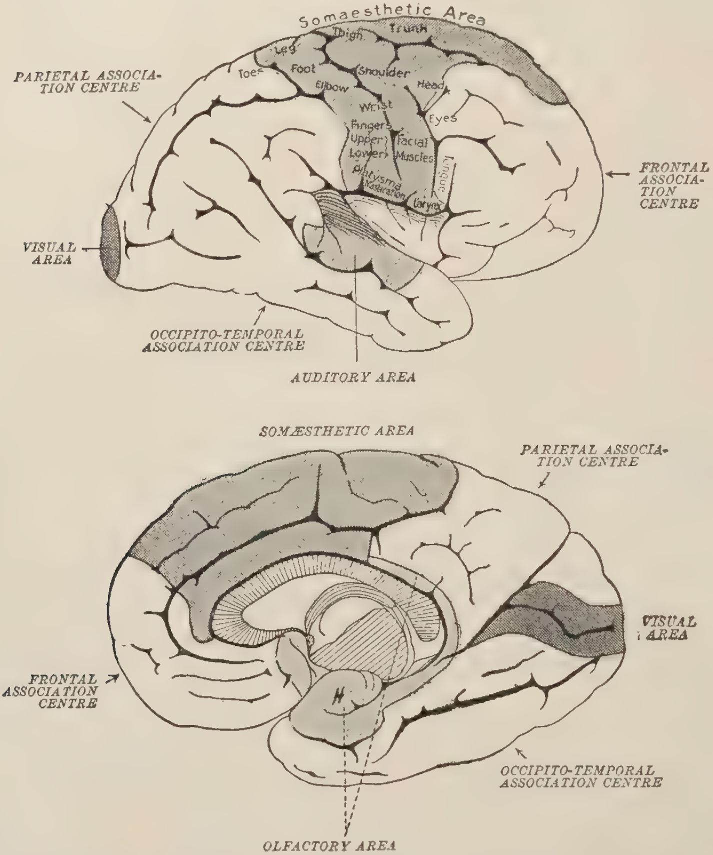
Somaesthetic Area
Thigh
Trunk
Leg
Toes
Foot
Shoulder
Head
Elbow
Wrist
Eyes
Fingers
Upper
Lower
Facial
Muscles
Tongue
Platysma
Mastication
Larynx
PARIETAL ASSOCIATION CENTRE
FRONTAL ASSOCIATION CENTRE
VISUAL AREA
OCCIPITO-TEMPORAL ASSOCIATION CENTRE
AUDITORY AREA
SOMÆSTHETIC AREA
PARIETAL ASSOCIATION CENTRE
VISUAL AREA
FRONTAL ASSOCIATION CENTRE
H
OCCIPITO-TEMPORAL ASSOCIATION CENTRE
OLFACTORY AREA

FIG. 18.—Diagrams of the two sides of the right cerebral hemisphere, indicating the localization of functions (from Morris). *Visual area* in occipital lobe; *auditory area* in temporal lobe; *olfactory area* in *H*, the hippocampal lobe. The *somaesthetic area* lies on both sides of the fissure of Rolando, the pre-Rolandic area being the area for voluntary movement and the post-Rolandic area receiving impulses for the skin, muscles, joints, tendons, and viscera. Broca's *speech area* is in the portion marked *tongue* on the diagram, and immediately anterior to it.

cases of obscure nervous diseases or of mental affections, no gross surface differences may be observable; the great motor and sensory tracts may be but little affected, although all the higher psychical activities are interfered with. The recent methods of studying, microscopically, the intimate structure of the cortex in these cases has added much to our knowledge.

By the use of these various methods, singly or in combination, it is possible to map out on the surface of the cerebral cortex certain areas with well-defined functions—thus, motor areas, sensory areas, and association areas are described. The motor areas have been determined with much accuracy; some of the sensory areas are also well known; the association areas, necessarily from their great complexity, are as yet but imperfectly understood. In a general way the cortex in front of the Rolandic fissure may be regarded as the great efferent[1] area, while the rest of the cortex is specialised for the reception of sensory impressions. It must not be forgotten, however, that the motor area has many afferent[2] (but not sensory) fibres, and it is by impulses through these that the motor cells are thrown into activity; hence the motor area is more accurately designated the psycho-motor area.

Motor area.—The motor area is situated immediately in front of the fissure of Rolando, occupying the greater part of the precentral convolution, and extending for a short distance into the hinder ends of the superior, middle, and inferior frontal convolutions[3] and on to the mesial[4] surface of the hemisphere. In this large area, individual regions can be recognised representing groups of associated movements. Thus the areas for the head and neck movements are situated at its lower end; for the arm and trunk movements about its middle; for the leg at the upper end and adjacent part of the mesial surface.

Sensory areas.—The sensory areas so far as they have been differentiated comprise (*a*) an area for general body sensibilities, i.e., the senses of pressure and temperature, and the muscular senses; (*b*) a visual area; (*c*) an auditory area; (*d*) an olfactory and gustatory area.

a) The region immediately behind the Rolandic fissure, i.e., the postcentral convolution and the parts adjacent to it, constitute the sensory area for the general body senses. No area associated with the sense of pain has as yet been found. (*b*) The visuo-sensory area is situated in the occipital lobe. (*c*) The auditory-sensory area occupies part of the temporal lobe. (*d*) The olfactory area is placed by most observers on the hippocampal convolution.[5] The area for the gustatory sense has not been satisfactorily determined, but is supposed to lie also on the hippocampal convolution behind the olfactory area.

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[1] An area made up of outgoing neurones.—EDITORS.

[2] Incoming.—EDITORS.

[3] Folds in the surface of the brain.—EDITORS.

[4] Middle.—EDITORS.

[5] A region on the lower middle surface of the cerebrum.—EDITORS.

Association areas.—When all the motor and sensory areas have been marked off, a considerable portion of the cortex still remains. This remainder consists of areas called association areas in which, it is supposed, elaborated impressions arrive from all the sensory areas and are combined into perceptions and conceptions. Four association areas are usually described: (1) frontal, immediately anterior to the motor area; the part of this region which forms the frontal pole is delimited as a special area, the prefrontal; (2) parietal, between the general sense area and the visual area; (3) temporal, occupying the greater part of the temporal lobe; (4) insular, the island of Reil.[1] Of these the prefrontal is the last to be formed and is supposed to be concerned with all the highest and latest acquired cerebral functions. In cases of insanity it is the region which is specially affected.

Five typical layers of cells and fibres enter into the structure of the cerebral cortex. These vary in relative thickness in the separate functional areas. By careful study of their development and arrangement, certain views as to their functions have been formulated. Thus the outer cells are said to subserve the psychic or associational functions of the brain, and are found best developed in the association areas. The middle cells receive and transform afferent impressions; they are well marked in the sensory areas. The inner cells are concerned in the lower voluntary and instinctive activities; it is the most important layer in the cortex of the lower animals.

Aphasia.—In certain diseases of the cerebrum, one or more of these areas may be affected, and thus several varieties of aphasia may be recognised. The first great division is into sensory and motor aphasias.

Sensory aphasia.—If certain portions of the auditory area be damaged, the patient is still able to hear spoken words but is quite unable to understand them—a condition known as word-deafness. It must be clearly understood that the patient is not deaf; he can hear ordinary sounds quite well, but spoken words with which he was formerly perfectly well acquainted become to him like the words of an unknown language.

Similarly when a certain portion of the visual area is damaged word-blindness results; the patient can see the written or printed words, but cannot comprehend them.

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[1] A region within the fissure of Sylvius.—EDITORS.

When the association areas for the combination of the sensori-memorial images from these regions are affected, the patient can still hear and see the words but cannot resolve them into ideas, and thus cannot express them.

In cases of pure sensory aphasia, the ability to speak and write in a mechanical manner is still retained by the patient, i.e., he can repeat words spoken to him, or can copy from manuscript, or write from dictation.

Motor aphasia.—The centre for articulate speech was localised by Broca in the hinder end of the inferior frontal convolution.[1] As all the great efferent paths are crossed, this centre is situated on the left hemisphere in right-handed individuals and on the right in left-handed people. Up till recently the proofs of the function of Broca's area were regarded as conclusive. It may be again emphasized that this area was not regarded as the motor centre for the muscles of speech; a patient suffering from motor aphasia may be able to pronounce words, but they are not the words suitable to his thoughts and he is often aware that he has said something quite absurd and foreign to the subject he wishes to indicate. In a similar way the centre for written speech was said to be localised immediately above the area of Broca.

Marie, however, has thrown great doubts on these views and has adduced evidence to show that all forms of aphasia are due to interference with the posterior association areas. In those forms where the patient is unable to produce articulate speech there is an additional injury in the region of the lenticular nucleus;[2] this is the only injury that can cause pure motor aphasia. Motor aphasias are due therefore to a combination of a cortical injury in the posterior association areas (aphasia proper) and a subcortical injury (anarthria). As a corollary to this, aphasia is always associated with an impairment of the intellectual powers.

II[3]

BY C. JUDSON HERRICK

The functions of the cerebral cortex are still largely wrapped in mystery, but the evidence thus far accumulated suggests that these functions are, so far as physiologically known, not different in kind from those of the other parts of the brain. It is, however, manifest that these functions are concerned with the individually acquired and especially the intellectually performed activities as distinguished from the fundamental reflex and instinctive processes whose mechanisms are innate. There is a specific localization of function in the cerebral cortex, in the sense that particular systems of sensory projection fibers terminate in special regions (the sensory projection centers), that from other special regions (the motor projection centers) particular systems of efferent fibers arise for connection with the lower motor centers related to groups of muscles concerned with the bodily movements, and that between these projection centers there are association centers, each of which has fibrous connections of a more or less definite pattern with all other parts of the cortex. The destruction of any part of the cortex or of the fiber tracts connected therewith involves, first, a permanent loss of the particular functions served by the neurons affected, and, in the second place, a transitory disturbance of the cortical equilibrium as a whole (diaschisis effect). Specific mental acts or faculties are not resident in particular cortical areas, but all conscious processes probably require the discharge of nervous energy throughout extensive regions of the cortex, and the character of the consciousness will depend in each case upon the dynamic pattern of this discharge and the sequence of function of its component systems. This pattern is inconceivably complex and only the grosser features are at present open to observation by experiment and pathological studies.

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[1] A region low on the frontal lobe.—EDITORS.

[2] A nucleus imbedded beneath the surface of the cerebrum.—EDITORS.

[3] Taken from *An Introduction to Neurology* (4th ed. revised), pp. 347–49. Philadelphia: W. B. Saunders Co., 1927.

No cortical area can properly be described as the exclusive center of a particular function. Such "centers" are merely nodal points in an exceedingly complex system of neurons which must act as a whole in order to perform any function whatsoever. Their relation to cerebral functions is analogous to that of the railway stations of a big city to traffic, each drawing from the whole city its appropriate share of passengers and freight; and their great clinical value grows out of just this segregation of fibers of like functional systems in a narrow space, and not to any mysterious power of generating psychic or any other special forces of their own.

The essence of cortical function is correlation, and a cortical center for the performance of a particular function is a physiological absurdity, save in the restricted sense described above, as a nodal point in a very complex system of associated conduction paths. Those reflexes whose simple functions can be localized in a single center have their mechanisms abundantly provided for in the brain stem. The cerebral cortex of the resting brain is probably in a state of incessant activity, i.e., it possesses a certain physiological "tone." This activity may be conceived as a system of equilibrated nervous discharges. This is not necessarily a conscious process, but it has a characteristic pattern in each individual which lies at the basis of his disposition or mental type. An effective stimulus disturbs this equilibrium and the precise effect will depend upon variable synaptic resistance or neuron thresholds which change with different states of the organisms as a whole and of the brain in particular. If this activity involves the cerebral cortex of a human brain, it may be a conscious activity, the kind of consciousness depending on the kind of discharge. But the consciousness must not be thought of as localized in any cortical area. The discharge in question may reverberate to the extreme limits of the nervous system and the peripheral activities may be as essential in determining the conscious content as the cortical.

C. Where Do Sensations Occur?[1]

BY GEORGE HENRY LEWES[2]

Ordinary language is correct when it says, "We see *with* our eyes, touch *with* our hands," and so on. The language of physiologists is less exact when it speaks of the various sensations having their seats in their respective sense-organs. Not that the physiologists mean this to be understood literally. What is it they do mean? They find certain conditions common to all sensations. First, there is a sensory nerve responsive to a particular order of stimuli. This, however, is not enough; for if the nerve is separated from its centre no stimulation produces sensation; hence the conclusion that the centre is the seat of sensation. This conclusion is, however, qualified by the discovery that just as the nerve isolated from its centre is insensible, so also is the centre isolated from the rest of the system. The final conclusion then is, that the sensory nerve is the indispensable *primary condition*—that which determines by its stimulation the peculiar kind of reaction; the centre to which that nerve goes is the *second condition, i.e.*, that of reaction, the centre, thus integrally one with its nerve, is in turn integrally one with the rest of the organism, and this is the *final condition* necessary to the transformation of an impression into a sensation.

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[1] Adapted by permission from *Problems of Life and Mind* (Third Series, "Problem the Second"), pp. 75–83. Boston: Houghton, Osgood & Co., 1880.

[2] It is the plea of Lewes in this passage that what we call conscious experience does not have a location in a single region of the nervous system. Instead it is something that occurs when the organism as a whole is active. Although Lewes wrote this a good many years ago, the point still needs making. When we are conscious we are conscious of objects, and perhaps it is this fact that makes us think of the act of being conscious as itself an object with a location in space. When we see a tree, we tend to assume that somewhere within us there must be a kind of copy of that tree which is the reality of "seeing the tree." In ancient times men thought that the tree must shed a kind of outer skin which, while maintaining the tree shape, could somehow fly into the individual who became conscious of seeing the tree. Even today it is not unusual to hear people speak as though states of consciousness were objects in the head instead of occurrences involving the *whole* organism and even the surrounding environment.

Thus physiology concurs with Common Sense in affirming that it is *we* who feel, *we* who think and will; not the brain, not any single organ, but the whole living organism. Yet the language, and often the express teaching, of physiologists is somewhat at variance with this, relying too much on analytical distinctions, and forgetting their artificial nature. What is to be understood by the *we?* It may signify the general function of the organism manifesting itself through the special functions of particular organs. In this meaning it is another aspect of Life. Or it may signify a particular group of vital functions—the sentient-motor group. In neither case does it stand for the function of a single organ; and for this reason: no single organ has a function at all when isolated from the organism.

The brain cannot therefore represent the *we*. It cannot be the Sensorium, but only an important part of the Sensorium. It cannot, because it is a single organ, and its function may be abolished without destruction of other functions—the brainless animal still lives, feels, co-ordinates its sensations and its movements, not, indeed, so variously as when in the possession of its brain, yet with sufficient energy to disprove the notion that the brain is the seat of all sensation and volition. The brain is simply one element in a complex mechanism, each element of which is a component of the Sensorium, or Sentient Ego. We may consider the several elements as forming a plexus of sensibilities, the solidarity of which is such that while each may separately be stimulated in a particular way, no one of them can be active without involving the activity of all the others.

The Sensorium, being a plexus of sensibilities, is of course differently compounded in different organisms, and even in different states of the same organism. An animal without eyes is not only insensible to the special stimulations of colour, but, in consequence of this, its sensorial states have a different composition from those of an animal which has eyes. The frightened squirrel runs from branch to branch; it cannot fly from branch to branch like a bird. Its reactions are diferent. The man who has been shaken by some calamity cannot behold the scene where it occurred with the same feelings, is not affected in the same way as another man in beholding the same spot. The mind which has certain organised impressions, intuitions, beliefs, interprets objective phenomena by these, reacts on the impressions differently from a man who has other organised impressions, intuitions, beliefs. The sentient mechanism has been often compared with a piano, which responds by particular tones and chords when particular keys and groups of keys are struck. But the comparison fails in an essential point. The keys respond only to the player's hand, each as it is struck; whereas the Sensorium responds by a variety of nascent feelings when any one sensory nerve is stimulated. A man who has taken santonine will see yellow colours where no yellow rays are present; a dog that sees an impending blow will cry out though untouched; a man who has eaten haschish may hear a fife, and this sound will raise within him sensations as of a vast orchestra accompanied by vivid images of dancing girls. That is to say, the excitation of one sensorial reaction is the excitation of many and various reactions. In consequence of this, we not only acquire the special modifications called *habits*, we also acquire *the habits of not yielding to our habits*, when a vision of injurious effects has been connected with the actions. This is our free will.

Coupled with the fact that particular sense-organs determine by their reaction particular directions of Sensibility, and give to each sensation its individual character, is the fact that no reaction of a sense-organ is a sensation unless compounded with the reaction of the Sensorium or general seat of Sensibility. This means that a sensation is a change in the sentient organism, and not simply a change in any one organ. Hence two hypotheses are open to us. We may view the Sensorium as a single organ, or portion of the central nervous system—say the brain—structurally and functionally detached from the several sense-organs, to which all the subordinate centres transmit their individual excitations, these being by it combined into a resultant

Or we may view it as the plexus of central terminations of the sensory nerves, the *solidarity of which involves its unity of reaction under every variety of excitation.* On a first glance there appears but a slight difference between these views. Slight as it may appear, it will be found to have immense significance, for it involves the question whether the analytical or the synthetical explanation is the true one.

The analytical explanation has been the one usually adopted. The desire to localise the phenomena in particular organs has led to the localisation in particular portions of an organ. After the cerebrum had once been fixed upon, it was soon decomposed into grey and white substances, each with its special attribute. Reid thought they were positive and negative, and compared them to oxygen and hydrogen. Haller thought the white substance was the origin of Sensation and motion. Willis thought the grey substance was the origin of the animal spirits, while the white substance conducted: an idea still current under slightly different expression. Gall thought the grey substance was the nutritive origin of nerve-force; and his successors have likened it to the galvanic battery, the white substance to the conducting wires.

Other attempts at localization may be mentioned. Descartes placed the Sensorium in the pineal gland (which, by the way, modern research discovers to be not even a nervous structure); Willis assigned it to the whole encephalon,[1] but distributed Perception to the *corpora striata*, Imagination to the *corpus callosum*, and Memory to the convolutions. Piccolhomini plausibly suggested the *medulla oblongata*, because it was the point of reunion of all the nerves of sense. Bartholinus and Sylvius, regarding the brain as a prolongation of the spinal cord, said the grey matter was the seat of sensation, the white that of movement.

Such notions excite a smile nowadays, and that, too, in men who see nothing absurd in assigning Thought to the grey matter of the cerebral convolutions, or even to certain cells in that matter, denying it to similar grey matter and similar cells found in other parts of the nervous tissue. Of all the attempts at localizing the Sensorium, that of Prochaska is the least unphysiological. Assuming that the Sensorium must be co-extensive with the origin or termination of all the nerves, he declared this to be the whole of the central nervous system *minus* the cerebral hemispheres. The hemispheres were excluded in obedience to the classic doctrine of Thought being essentially distinct from Feeling, the hemispheres alone having the function of Thought. According to this hypothesis, the operations of the cerebrum only become conscious states when reflected downwards on the lower centres—the Sensorium.

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[1] The brain.—EDITORS.

Dr. Todd, Dr. Carpenter, Luys, and some others propose a modification of Prochaska's view, limiting Consciousness or Feeling to the basal ganglia. I think that of Prochaska preferable; but I should include the cerebral hemisphere and the whole of the central axis in the same plexus, because anatomical and physiological evidence converge to show that cerebrum, medulla, and spinal cord are purely topographical distinctions in the one continuous central axis, having in common the same general substance, the same general structure, the same general properties, and the same laws of excitation and reflexion.

It is on this ground that I define the Sensorium "a plexus of sensibilities"— in other words, "the sum of the conditions requisite for the production of Sentience." If we adopt the convenient artifice which assigns Sensibility to the neuromuscular System, with only a tacit implication of the rest of the living organism, we may also assign to the peripheral portions of the system the office of Stimulation, and to the central portions the office of Reaction. This, however, must be accompanied by the understood recognition that nerves and centres together form one system, stimulation and reaction together form one function. If we separate them, it is for the convenience of exposition.

To forget this is to render inexplicable the power of the Mind over the Body. The fact thus expressed is undisputed. Its explanation becomes a puzzle when the Mind is ideally separated from the Body, and conceived to be an Existent *sui generis* which is supposed to operate on the Body. To the physiologist there need be no more mystery in this influence of Mind than in any other vital phenomenon; the excitation of Movement consequent on sensation being to him an ultimate fact. When, therefore, we reduce the abstract term Mind to its concretes, namely, states of the sentient mechanism, the "power of the Mind" simply means the stimulative and regulative processes which ensue on sentient excitation.

We may now formulate a conclusion: Sensibility is the special property of the nervous tissue. Every bit of that tissue is sensitive in so far that it is capable of entering as a *sensible component* into a group, the *resultant* of which is a *feeling—i.e.*, a change in the state of the sentient organism.

The *Sensorium is the whole which reacts on the stimulation of any particular portion of that whole.* That is to say, when the mechanism is stimulated by the agency of a peripheral nerve, this reacting-mechanism is the seat of Sentience, representing as it does the whole of the system not engaged in the (ideally) different process of stimulation.

In like manner when the stimulation proceeds from some central portion, say the central convolutions, the Sensorium then is the whole of the central mass engaged in reacting.

We are thus to understand that the Sensorium does not mean any one fixed and defined organ or portion of the central mass, but the ideal conception of a *movable centre.* It is the organism conceived as reacting on the stimulations of its organs. Any one feeling is an attitude of the organism. This attitude depends on the conditions then and there operating: it is the resultant of complex components—present stimulations blended with revivals of past stimulation. Every impression from an external source gives its particular direction; this is either met by some counter-direction, and is arrested, or is blended with others into a group. The final issue is the attitude of the organism. The attitude represents the particular feeling, the organism represents the *We.*

D. The Complexity of the Brain[1]

BY C. JUDSON HERRICK

The scientific study of man is the most difficult of all branches of knowledge.—Oliver Wendell Holmes

The known complexity of the lines of nervous conduction within even so simple a brain as that of a frog, if mapped out in detail, would make the wiring chart of the largest electrically driven factory look as simple as a county-road map. And if we turn to the human brain it is no exaggeration to say that a complete map of every circuit in all the telegraph and telephone lines of the North American continent would be incomparably simpler than such a chart of the nervous circuits of which we already have some knowledge. And the half of our nervous equipment has never been told.

Recently, in conversation with a mathematician, we were commenting on some of the stupendous numbers employed by the astronomers in measuring the distances of the stars. The unit of measure here is the light-year, that is, the distance traversed by light in a year—about six million million miles, or 6×10^{12}. The nearest fixed star whose distance has been measured, alpha Centauri, is about four light-years from the earth, and it has recently been estimated that the giant nebula Andromeda is about a million light-years away. Expressed in miles, the distance to the star alpha Centauri is about 24×10^{12} and to Andromeda about 6×10^{18}.

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[1] Adapted from *Brains of Rats and Men,* pp. 2–11. Chicago: University of Chicago Press, 1926.

Turning now to smaller things, the diameters of the atoms have been computed. My mathematical friend tells me that in a cubic centimeter of water the number of atoms is 10^{24}. Extending the computation, the solar system contains 10^{56} atoms and the entire visible sidereal universe contains about 10^{65} atoms.

Such numbers stun the imagination of the non-mathematical mind. But a little computation shows that the known complexity of the nervous connections of the human body present possibilities of associational combinations of the nerve cells among themselves that run into numbers of even greater orders of magnitude.

The total number of cells in the human body has been estimated by Francke to be about 2.65×10^{13}, a number which is probably too small. Of this total, the larger proportion (2.25×10^{13}) are blood corpuscles which float freely in the blood stream. Donaldson estimates that there are about twelve thousand million (12×10^{9}) nerve cells or neurons in the human brain, and more than half of these, or ninety-two hundred million (9.2×10^{9}), are in the cerebral cortex (Thompson, 1899).

Each blood corpuscle is practically an independent organism. It may do its work independently of any of the other cells of the body. But the most characteristic thing about the nerve-cells, with the related nerve-fibers, is that they are conductors; their most significant function is to connect various parts of the body so that these parts may co-operate in the performance of some activity. Each of these neurons has fibrous outgrowths which may connect directly or indirectly with many hundreds of other neurons. This is particularly true of the nerve cells of the cerebral cortex.

Two million blood corpuscles may do twice as much work as one million; but two million cortical neurons are not twice as efficient as one million such elements, for the functional value of any cortical structure is measured by the complexity of the interconnections of its neurons one with another, not directly by the number of these elements. Two million cortical neurons may provide the mechanism of behavior patterns which are incomparably more complex than those which are possible with one million such cells.

If a million cortical nerve-cells were connected one with another in groups of only two neurons each in all possible combinations, the number of different patterns of interneuronic connection thus provided would be expressed by $10^{2,783,000}$. This, of course, is not the actual structure, as we shall see; but the illustration may serve to impress upon us the inconceivable complexity of the interconnections of the ninety-two hundred million nerve cells known to exist in the cerebral cortex.

Every neuron of the cerebral cortex is enmeshed in a tangle of very fine nerve fibers of great complexity, some of which come from very remote parts. It is probably safe to say that the majority of the cortical neurons are directly or indirectly connected with every cortical field. This is the anatomical basis of cortical associational processes. The interconnections of these associational fibers form an anatomical mechanism which permits, during a train of cortical associations, numbers of different functional combinations of cortical neurons that far surpass any figures ever suggested by the astronomers in measuring the distances of stars. And in the cortical association centers it is the capacity for making this sort of combination and recombination of the nervous elements that determines the practical value of the system.

In the retina of each eye it has been estimated by Krause that there are about one hundred and thirty-seven million rods and cones. When the visual area of the cerebral cortex is activated following the stimulation of the retina by some particular field of view, it is safe to say that at least a million cortical nerve cells are directly stimulated by the nervous impulses which discharge into this cortex from the optic thalamus. These million cells activate other millions, and so on in indefinite series, and the aggregate of the connections actually made in any extended associational process is evidently an enormous number. This may be illustrated by some further computations.

The known arrangement of cortical intercellular connections may be crudely and very conservatively expressed by saying that each of the million cells which we suppose to be stimulated in the visual area is directly connected with ten others, each of these with ten others, and so on in series. A diagram of this simple geometrical progression would look like a family-tree in which each of a million families has ten children, each of these ten, and so on. If we start with the excitation of a million cortical cells, each of these nervous impulses is multiplied tenfold at every step in the ramification of the nerve-fibers, and at the fourth member of this series (the fourth generation of our genealogical tree) more than the total of nine thousand million cortical cells would be involved.

But the structure is not really so simple as this. The arrangement of cortical associational connections is not that of a simple geometric progression, for the lines of connection cross in all imaginable patterns and any one of the nine thousand million cortical neurons may be represented in very many of the possible associational patterns. To recur to our analogy of a genealogical tree of a million families, the family lines do not run on quite independently of one another, but by intermarriage each family-tree is related with all of the others.

Upon activation of the visual cortical field by the sight of the litter of the day's work upon my study table, associational processes are immediately set up within the cortex and each of the million excited cells of the visual area activates at least ten others, and each of these, in turn, ten others, and again on and on as long as the cortical process continues. And any particular cortical neuron may be repeatedly activated in different associational patterns, and the range of variety of these possible combinations cannot be exactly formulated in mathematical terms. For practical purposes it may be regarded as approaching infinity.

On the basis of the known structure of the cortex, the following computation may be regarded as a conservative statement of the number of intercellular connections that are anatomically present and available for use in a short series of cortical associational processes. Starting again with a million (10^6) cortical neurons of the visual area simultaneously excited by some retinal image, each of these certainly activates at least ten others (10^7) and each of these in turn ten others (10^8). From each of these last neurons associational fibers go out that may reach the extreme dimensions of the cortex, and at this stage of the process the 10^8 neurons in actual function may act upon a considerable part of the entire cerebral cortex, some parts being intensely activated and other parts being so slightly affected as not to reach the threshold of stimulation.

But the associational process has just begun. From each of these foci of cortical activity, lines of nervous conduction irradiate in definite patterns depending on the particular trains of association that are set up, and these lines of transmission may be activated in momentarily changing patterns of unlimited complexity. If for simplicity of computation we limit ourselves to one million of the 10^8 neurons already activated in the process, and if we assume that these may be recombined among themselves in all theoretically possible patterns, the total number of such connections would far exceed the $10^{2,783,000}$ already mentioned as the theoretically possible combinations in groups of two only. Not all of these theoretic combinations are actually present anatomically, but a large proportion of them certainly are structurally there.

Of course, in any one series of cortical associations only a minute fraction of the anatomically present connections are really in action, but as the patterns of cortical associations change from moment to moment the total of anatomically present intercellular connections that may be activated is so large a number that it seems futile to attempt to express it in figures. These are the possible combinations, not those actually working.

During a few minutes of intense cortical activity the number of interneuronic connections actually made (counting also those that are activated more than once in different associational patterns) may well be as great as the total number of atoms in the solar system. Certainly not all anatomically present connections of nervous elements are ever used, but the *potentialities* of diversity of cortical associational combinations are practically unlimited and the personal experience of the individual is probably an important factor in determining which of these possibilities will be actually realized.

The efficiency of the cortex, what practical use we can make of these potential intercellular associational connections, seems to depend in the first place upon the number and character of the associational patterns that are laid down as enduring structural records of past experience (that is, the number and character of our memory vestiges—what we have learned), and in the second place upon the facility with which these memory patterns can be reactivated in useful combinations (that is, the extent to which knowledge previously acquired can be fitted into new situations).

These cortical potentialities form the organic background of those reserves of power and capacity and those latent possibilities of education and constructive thinking that are present in all of us and yet too often never come to practical expression, as James has so graphically portrayed in his discussion of "The Energies of Men" (1907).

All this means that when the auditory cortical field is activated—say by the sound of the dinner bell—or the visual cortical field is activated—say by the sight of the table spread in the dining-room—the associational fibers which reach out from these cortical fields may in turn activate remote parts of the cortex in diverse patterns in unimaginable complexity, depending upon the innate architecture of the cortex and the past experience of the individual. Specific memory vestiges of previous related experiences are reactivated, and each of these irradiated nervous excitations implies the quickening into functional activity of many millions of nerve cells related to one another in some definite structural pattern.

As the hostess gives her dining table a final appraising glance, many things flash through her mind. Is the service properly appointed? Are the courses ready in the kitchen in proper sequence? Has the seating of the guests been tactfully planned? Mrs. Wilbur's new yellow gown will clash with her neighbor's softer colors, and a reseating is imperative. Has the choleric Colonel Blair composed his quarrel with Mr. Nesbit? All this and more is done during the flash of an eye, but in that tense moment we may be sure that neurons to the number of countless millions are all very busy, transmitting their messages hither and yon throughout the entire cortex as now one then another associational pattern is momentarily activated.

The simplified neurologic schemata which we use as pedagogic devices are necessary instruments for unlocking those doors of the student's mind which lead into the more recondite secrets of nervous organization. But having opened the door in this way, the key should be laid aside and not regarded as even an adequate symbol of the actual organization, as is so often done in both clinical and psychological practice. The inconceivable intricacy of the structural connections within the brain is generally underestimated even by neurologists. And to speak of memories or any other unitary cortical functions as localized in some particular cells or in some small cortical areas is to talk neurological nonsense.

5. THE FORM, SIZE, AND WEIGHT OF THE BRAIN, AND THEIR RELATION TO INTELLIGENCE

In a general way, the size and form of the brain is determined by the size and form of the cranial cavity. Some skulls are relatively long and narrow, others short and broad, and these variations correspond to general variations in the shape of the brain. But conformation of the skull, as seen from the *outside*, is not an accurate indication of the conformation of the brain within.

The size of the brain is somewhat proportionate to the size of the body. This is true both of different types of vertebrate forms, and of individuals of any type.

The following list[1] gives the approximate brain-weights and body-weights of a number of animals:

	Brain-Weight in Grams	Body-Weight in Grams
Mouse	0.4	20
Squirrel	6	400
Cat	30	3,500
Beaver	35	20,000
Kangaroo	65	45,000
Monkey (macaque)	100	5,000
Dog (very large)	120	46,000
Sheep	130	50,000
Lion	220	120,000
Seal	300	26,000
Bear	400	200,000
Gorilla	400	90,000
Moose	435	200,000
Cow	450	175,000
Porpoise	500	55,000
Hippopotamus	580	1,750,000
Horse	600	300,000
Giraffe	680	530,000
Man	1,400	70,000
Elephant	5,000	2,500,000
Whale	7,000	70,000,000

Man does not possess the heaviest brain. The brain of the elephant is about three and one-half times as heavy, and that of the whale about five times as heavy. So it is apparent that the heaviest brain does not necessarily indicate the greatest degree of intelligence. We know that some larger animals possess greater intelligence than some smaller animals. For example, the monkey is more intelligent than the rat. But it cannot be said that the degree of intelligence is proportionate to the actual weight of the brain.

While the weight of the brain is somewhat proportionate to the weight of the body, the relative weight of the brain and body varies markedly among different animals. The relative size of the brain is greater among smaller animals. The elephant and whale have proportionately smaller brains than man, and the song birds, apes, and mice proportionately larger brains than man. So that we may not conclude that even the relatively larger brains indicate the greater degrees of intelligence. It has been shown, however, that if one compares the weight of the brain and spinal cord, the weight of the brain of man is greater in proportion to the spinal cord than that of any other mammal. In man, the weight of the cord is about 2 per cent of the brain-weight, in apes about 6 per cent, and ranges from 23 to 47 per cent among other mammals.

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[1] From Ladd and Woodworth, after Warneke.

The following list shows racial differences:

		Grams
Caucasian race:	average brain-weight,	1,335
Chinese:	average brain-weight,	1,332
Sandwich Islander:	average brain-weight,	1,303
Malay and Indian:	average brain-weight,	1,266
Negro:	average brain-weight,	1,244
Australian:	average brain-weight,	1,185

There are also recorded the following differences in brain-weight among European nations.[1]

		Grams
German:	average brain-weight,	1,425
English:	average brain-weight,	1,346
French:	average brain-weight,	1,280

There has been much interest in the question as to whether among *individuals* of the human race a larger brain is related to a greater degree of intelligence. The average weight of adult human male brains is about 1,360 grams and that of females, about 1,250 grams (Herrick). Those of idiots run as low as 300 grams and less, and very high weights (2,028 and 1,900 grams) have been found among individuals of very low mentality. The average weight of the brains of approximately one hundred men of considerable eminence is about 1,470 grams. This is between 2 and 4 per cent above that of inmates of workhouses, whose brain-weights range from 1,200 to 2,000 grams. The list on page 78 gives the brain-weights of a number of eminent men.

This list shows that while most of these brains are heavier than the average, there are also men of exceptional ability whose brain-weight is considerably below the average. The investigations of Goring, comparing body and skull measurements of a large group of men in English prisons with those of college students and professional men, indicate that there are no significant differences in the measurements of the two groups as to *size* and *shape* of the head.

The brain increases in weight markedly during the first year of life, increases more slowly until the eighth to tenth year, and after that grows little. It is probable that the maximum weight is reached at about the fifteenth year. There is then a very gradual decrease in weight until old age approaches, when the decrease is marked.

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[1] This list and the one above are quoted from Villiger.

	Grams
Turgenjeff	2,012
Cuvier	1,830
Byron	1,807
Thackeray	1,658
Siemens	1,600
Kant	1,600
Schiller	1,580
Daniel Webster	1,518
Chalmers	1,503
Agassiz	1,495
De Morgan	1,494
Gauss	1,492
Broca	1,484
Dante	1,420
Grote	1,410
Bertillon	1,398
Liebig	1,352
Tiedeman	1,254
Döllinger	1,207

The average weight of women's brains is less than that of men's. In proportion to the weight of the body, the weight of women's brains is the same as that of the men, or possibly slightly heavier.

It is apparent that differences in shape, size, and weight of brains is no measure, in man at least, of differences in intellectual ability. These differences are doubtless related to minute changes in growth and structure, and to methods of functioning.

EXERCISES

1. Explain why complex activities are more dependent upon the higher centers than are simple ones.
2. Practice until you can draw from memory a diagram of the brain showing the locations of the sensory and motor areas.
3. Reconcile Lewes' statement with the fact that definite sensory areas have been localized in the brain.
4. The brain of woman is, on the average, considerably smaller and lighter than that of man. Explain why, in spite of this, there is no marked difference in intelligence between the two sexes.

CHAPTER IV

REFLEX ACTION AND INSTINCT

1. FORMS OF ANIMAL BEHAVIOR[1]

BY S. J. HOLMES

A classification of the many things which animals do has, I believe, an interest not only for animal psychology but for human psychology as well; and I have therefore attempted to make a grouping of the various forms of animal behavior. What is designated as behavior is not sharply demarcated from the physiological functioning of the body. But while such activities as respiratory movements, sneezing, coughing, etc., may fall under both categories, most behavior is clearly distinguished from physiological functioning as such, although the latter is, of course, involved in behavior as in all the other activities of the organism.

The tentative grouping of animal activities that is here sketched is based in part on the ends subserved by different kinds of behavior and in part on certain general similarities which various kinds of behavior exhibit. Only to a minor extent is any use made of possible genetic affinities of different kinds of activities. The procedure is somewhat akin to what one would follow in essaying a classification of organs or diseases or the occupations followed by human beings. In classifying kinds of behavior one is at liberty to proceed on a number of different principles. Professor Warren in his recent paper has classed reflexes into four groups according to the degree to which they may be modified or inhibited by higher processes. When he passes to instincts he employs a quite different basis of grouping.

Making our primary subdivisions on the basis of the relation of behavior to the welfare of species, we may group activities into (1) those which are adaptive, and (2) those which are not, and the former may be divided into (1*a*) those which are concerned with the preservation of the individual, and (1*b*) those concerned with the perpetuation of the race. Most kinds of behavior which have been recognized and described have in some way or another something to do with the preservation of the species. Mr. Spencer's definition of life as the continuous adjustment of internal relations to external relations, laying emphasis as it does on adjustment (i.e., adaptation) practically ignores the existence of anything in vital activity which does not make either for individual or race preservation. In his interesting but somewhat disappointing chapter on the dynamic element in life in the second edition of his *Principles of Biology*, Mr. Spencer gives a belated recognition of the inadequacy of his previous formula in that, among other shortcomings, it does not provide for various forms of dysteleological activity. The primary group of dysteleological kinds of behavior is of course a hodge-podge of all sorts of performances resembling each other in nothing except their lack of utility. It is a group recruited from all kinds of behavior, simple and complex, individual and social. Many of the acts in this category are mere aberrant derivatives of purposive acts or acts misdirected or misapplied. Many are the expression of sheer undirected activity. Some acts, like the fits of animals, are pathological. Others may be the expression of old forms of behavior which persist like rudimentary organs under circumstances with which they are not in harmony. Some, like tropistic responses to the electric current and to a less extent other tropisms, may be an incidental result of the creature's organization occurring with no reference to its welfare. A large and instructive treatise might be written on such forms of behavior. Obviously it would be much more voluminous if it included the behavior of man.

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[1] Adapted from "A Tentative Classification of the Forms of Animal Behavior," *Journal of Comparative Psychology* (Williams and Wilkins, publishers) II (1922), 173–86.

The division of purposive behavior into self-maintaining and race-maintaining needs no comment. It is as old as Aristotle and represents a perfectly obvious cleavage, although it is equally obvious that many subordinate activities subserve both ends. Self-maintaining activities are grouped into three divisions, (1) the sustentative which concern themselves with food, water, oxygen, etc., (2) the protective, and (3) the ameliorative. Most animal activities concerned with self preservation are either directed toward securing nutriment or protecting the body from inimical agencies. Nevertheless there is a group of acts which, while promoting life, can scarcely be called protective without extending considerable and perhaps unduly the ordinary meaning of that term. Such performances as sleeping or basking in the sun, if we call these acts, or at any rate such performances as mere exercise and many forms of play are only protective in a very indirect sense, although they may conduce to the preservation of the body. I have accordingly grouped such indirectly preservative acts under a distinct category designated ameliorative. A pig wallowing comfortably in the mud affords a good illustration of behavior coming under this rubric.

Recurring to the sustentative activities, it may be pointed out that these fall into a number of different classes. Oldest, phylogenetically, are the movements directly concerned with taking in or swallowing food. As animals become more highly developed, we meet with an elaboration of preparatory or subsidiary actions. Thus associated with taking in food are acts which bring the organism in contact with food, and acts which involve a discrimination between what serves as food and what does not. In many animals taking in food is preceded

TABLE II

General Grouping of Animal Activities

Behavior	Non-adaptive			Useless tropistic reactions Misdirected instinct Abnormal sex behavior Pathological activity: fits Useless social activity Superfluous random movements
	Adaptive	Self-maintaining	Sustentative	Devouring food Discrimination of food Capture of food Activities preparatory to capture as making snares, pitfalls hunting, stalking Collection of food, digging, boring gnawing Migration Caring for food for future use, hiding, burying, storing Preparation of food
			Protective	Against enemies (see Table III), Against inanimate forces, reactions to heat, light, gravity, chemicals, etc Against inanimate objects, i.e., avoidance of moving objects, cleaning movements, etc.
			Ameliorative	Rest, sleep, exercise, play, basking
		Race-maintaining	Sexual behavior	Of male toward female: Copulation Sex discrimination, seeking the female Courtship, sex calls Battling for female Of female toward male: Resisting, accepting, alluring, coyness
			Parental behavior (See Table IV)	Parents toward offspring Offspring toward parents
			Social behavior (see Table V)	Sustentative Protective Ameliorative

by capturing or overcoming some other organisms, or by other activities such as digging, boring or gnawing. In higher forms, especially, activities accessory to these are added such as hunting, making snares or lying in wait. In exceptional cases there may be storing of food, as in rodents, many bees, and some species of ants. Even more elaborate behavior is occasionally developed, as shown in leaf-cutting ants, which devour fungi grown upon the prepared leaves which are carried to the nest. The elaboration of activities of varying degrees of indirectness which are subsidiary to food taking would afford an interesting phylogenic enquiry to which we can do no more here than simply call attention.

Protective activities may be grouped into those concerned with general forces such as heat, light, gravity, etc., and those concerned with definite objects. Under the former come most of the forms of behavior commonly called tropisms,[1] in so far as these are directly or indirectly subservient to life. For most purposes of analysis, however, it is doubtless most advantageous to consider tropisms as general modes of response quite regardless of their utility.

Reactions of a protective nature directed to specific objects are common and fall quite naturally into two groups: (1) those in relation to living objects, usually enemies, and (2) those in relation to objects which are not living. Protection from enemies may be secured (*a*) through escaping from them by some means, or (*b*) by standing ground and making some defense. Defense may be accomplished by (1*b*) offering passive resistance such as closing a shell, erecting spines, or otherwise rendering the animal difficult to attack. Or (2*b*) an animal may defend itself by actively inflicting some injury on its assailant. Primarily such active defense consists in retaliatory infliction of injury after attack. But in some cases, especially in higher forms, we meet with an aggressive pugnacity which does not wait for an attack to be made, but incites to attacks which are apparently unprovoked. The function of such gratuitous hostility is, however, primarily protective. It is often advantageous to take the offensive against a potential enemy. Animals which are particularly irascible are often given a wide berth and this often means the undisputed possession of many desirable things. To a certain extent, also, aggressive pugnacity may be the expression of the fighting instinct which, if it does not find sufficient exercise through provocation, may tend to discharge itself without the usual stimulus.

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[1] The term tropism refers to the tendency of an organism to turn or move, wholly or in part, toward the source of stimulation, as turning toward light (heliotropism), etc.—EDITORS.

TABLE III

Forms of Self-maintaining Protective Behavior toward Enemies

Protective behavior against enemies	By escape			Flight
				Death feigning
				Deceptive quiet
				Hiding
				Disguising, emitting ink
				Changing color
				Making protective habitats, holes, etc.
	By defense	Passive		Closure of shell or habitation
				Rolling up (pill bugs, armadillo)
				Erecting spines
				Emitting odors
		Active	Retaliatory	Biting, clawing
				Kicking, stinging
				Hunting parasites
				Fighting plays
			Anticipatory	Same acts that fall under retaliatory defense

Along with active defense should be placed playful or make-believe fighting which is so common among higher animals and which may be regarded, in accord with the theory of Groos, as preparatory to serious encounters.

Activities directly or indirectly subservient to race maintenance form a large and varied group. Obviously, they include (first), sex behavior, and (second), parental care, and I have also placed (third), social behavior under this head because such behavior, while often subserving the interest of the individual, is primarily of service to the group and much of it is probably derived phylogenetically from activities concerned with the maintenance of the family. Sex behavior is devoted to the end of securing the meeting of ova and spermatozoa. It emerges gradually from the simple physiological functions of forming and discharging the sex cells. There is no sex behavior properly so-called in sponges, coelenterates, echinoderms, many mollusks (such as lamellibranchs) and various other invertebrates which simply discharge their sex cells into the water and leave their meeting to chance. In some of the Protozoa we may have sex behavior involved in conjugation, the relation of which to the behavior of gametes in multicellular organisms we shall not here discuss. Some of the invertebrates discharge their sex cells under the stimulus afforded by the proximity of the other sex and in animals in which internal fertilization does not occur we often find strong instincts leading to a close association of the sexes and a simultaneous discharge of the sex cells during the breeding season as in many fishes. In some animals that discharge their sex into the water, proximity is insured by the development of instincts of the male to seize and retain the female as in frogs and toads. Association of the sexes, whether it involves internal fertilization and the consequent development of copulation, or whether it involves the delicate responsiveness insuring the simultaneous discharge of sex products into the water, entails the development of the power of sex recognition and activities on the part of the males for seeking and seizing the females. Such a procedure involves a whole stream of accessory activities which have been of the greatest importance in the evolution of behavior. Courtship, the song of birds, battles on the part of males for the possession of females with the accompanying evolution of larger size, strength, weapons of defense and pugnacity in the male sex, are among the many subsidiary developments which have gradually been added to the primary function of sex. The evolution of sex behavior, although most conspicuous in the male, has had its complementary counterparts in the female sex in the development of various instincts such as coyness and alluring instincts, as well as other acts more closely associated with the propagation of the species.

The category of parental behavior is used in a broad sense to include not only the behavior of parents toward offspring but the reactions of offspring to parents, and, in the former case, the behavior of parents not only toward young, but in relation to the eggs from which the young are to emerge. Behavior toward eggs includes the activities of egg laying, protecting and incubating eggs, nest building, selecting a site for eggs and often providing food for larvae to which the eggs will give rise. As I have elsewhere attempted to show,[1] care for young first developed by extending care directed to eggs to what comes out of the eggs. And when this step is taken a line of evolution is entered upon which has led not only to greater and greater extensions and elaborations of parental care, but also to the various forms of social behavior.

As the care for offspring has evolved there has been a coördinate development of behavior of the young toward their parents. Following, cuddling, making cries, obeying signals, such as the danger chirr of the domestic hen, and imitation are among the acts by which the young derive benefit from the association with their parents, and many of these acts come, in time, to have a significance in social life far beyond the limits of the family group.

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[1] *Studies in Animal Behavior*, chap. ii, "The Evolution of Parental Care."

Social behavior, like self-maintaining behavior, I have divided into the sustentative, the protective and the ameliorative. There are sustentative activities which are social, such as mutual feeding among ants, bees and termites, collecting, preparing and storing food for the group, leading others to food, as in ants, and group attacks upon prey, as in packs of wolves. But most social behavior is primarily protective. And protective social behavior, like protective individual behavior, is directed (1) toward inanimate forces and objects on the one hand, and (2) toward animate creatures, largely in the form of enemies, on the other. Under the first there is the construction of common habitations or other means of shelter against the elements, and keeping the habitation clean (as in ants and bees). The chief protective efforts of animals, however, are concerned with other living creatures. The most primitive exhibition of such behavior is direct coöperative defense against an attacking enemy. Shelter making is often more for defense against enemies than for protection from the elements. Coöperative offensive undertakings naturally grow out of defensive efforts as in individual behavior and may likewise be regarded as primarily anticipatory defense. Actions subsidiary to defense

TABLE IV

FORMS OF PARENTAL BEHAVIOR

Parental behavior	Parents toward offspring	Egg laying	Oviposition
			Selecting suitable places or hosts (as in parasites)
			Preparation of places for eggs
		Nest building, hole digging	
		Incubation	
		Provisioning eggs	
		Protecting eggs, nest, or young	Concealing
			Brooding
			Carrying eggs or young
			Decoying away enemies
			Fighting enemies
			Keeping eggs or young in optimum temperature, moisture, etc.
		Feeding young	
		Cleaning young or nest	
		Training young	
	Offspring toward parents	Feeding, sucking, response to parental feeding	
		Clinging	
		Cuddling	
		Making cries	
		Following	
		Obeying calls	
		Imitation	

naturally assume importance as life becomes more complex. We see the development of warning behavior, danger cries, the posting of sentinels, and the communication of a hostile attitude by the spread of the angry hum in a hive of bees. Besides the defensive actions of social animals and the actions immediately subservient to the function of protection, there is a large class of social activities whose connection with defense is quite indirect but whose *raison d' être* is nevertheless to be found, at least in part, in their subservience to this end. The instincts which make for social subordination such as bashfulness, the tendency to attack or suppress the egregious, sequacity, and to a certain extent imitation, make indirectly for the solidarity of the group upon which successful defense often depends. Mutual aid and the sympathy by which in higher forms such aid is prompted, as well as many of the play activities of social animals contribute also to the same end. On the other hand, we have the instinctive exhibition of pride, self-assertion, the tendency to dominate and assume leadership entering, along with apparently opposite or contradictory traits, into the composition of the higher animals and man. I shall not discuss the interesting problem of how far the original nature of man can be interpreted from the standpoint of adaptive responses. There is in all animals, and possibly to a relatively large extent in human beings, an ingredient of biologically non-significant behavior. How large

TABLE V

Classification of the Forms of Social Behavior

Sustentative	Mutual feeding (feeding of queens and drones)		
	Coöperative food getting		By discovery of food and communication By overcoming prey
	Food storing		
	Food preparing (leaf-cutting ants, honey ants)		
Protective	Against inanimate forces or objects		Mutual shelter making and seeking Mutual cleaning and habitat cleaning Huddling together for warmth
	Against enemies	Direct	Shelter making Mutual warning by cries and acts, sentinel posting Coöperative defense Coöperative offensive attacks (anticipatory defense)
		Indirect	Social play, music Social self-assertion, pride, showing off, domineering Social subordination, following, bashfulness, modesty Communication Imitation Suppressing the egregious Manifestations of sympathy and affection
Ameliorative	Many social plays and amusements Music Aesthetic activity		

is this ingredient of undisciplined activity which has never been worked in for military service is difficult to determine. The Darwinian must agree with the dictum of Schiller, "Ernst ist das Leben,"—life is serious business. But while life is ever devoted to its own maintenance, to a considerable and not accurately determined extent it indulges in just frills. The Darwinians may argue, often with reason, that what appear to be just frills have nevertheless their indirect utility. The Groos theory of play would reduce the most wanton gambols of young lambs to preparation for the serious business of later life. Even our social plays and sports may prepare for social life and tend to promote social solidarity. But even accepting such an interpretation of play as valid, it can at least represent but a general truth. Just as naturalists are coming to regard many of the specific characteristics of organisms of no utility, so there are many acts which have no biological value or are even injurious. And when we come to interpret the behavior of human beings in relation to a physical and social environment that is ever changing, it is obvious, I believe, that such behavior should become much more common.

To a larger extent than obtains in lower forms, perhaps, social behavior in higher animals, and especially in man, may be described as ameliorative, although it is always difficult to draw a distinction between this category and acts which are indirectly protective. Much of human social behavior, when it has any biological significance at all, is not directed toward preparing, even in sport, for any particular defensive action. Our various forms of amusement, so far as they can be said to enhance life, have a general rather than a specific benefit. The same is probably true, although to a less extent, of the social plays of animals.

The foregoing classification of animal activities is confessedly imperfect in many ways. It presents only one system of grouping out of many which might be devised and which may have their special advantages. The attempt to class forms of behavior naturally suggests many problems of derivation of forms of activity. It is perhaps useful in aiding us to gain a comprehensive view of animal activities; it may help us to conceive how they have unfolded, how accessory activities have been added to primitive ones, and to understand how forms of behavior have become interrelated in various ways in the course of evolution.

2. THE ORIGINAL NATURE OF MAN[1]

BY EDWARD L. THORNDIKE

NAMES FOR ORIGINAL TENDENCIES

Three terms, reflexes, instincts, and inborn capacities, divide the work of naming man's unlearned tendencies. When the tendency concerns a very definite and uniform response to a very simple sensory situation, and when the connection between the situation and the response is very hard to modify and is also very strong so that it is almost inevitable, the connection or response to which it leads is called a reflex. Thus the knee-jerk is a very definite and uniform response to the simple sense-stimulus of sudden hard pressure against a certain spot. It is hard to lessen, to increase, or otherwise control the movement, and, given the situation, the response almost always comes. When the response is more indefinite, the situation more complex, and the connection more modifiable, instinct becomes the customary term. Thus one's misery at being scorned is too indefinite a response to too complex a situation and is too easily modifiable to be called a reflex. When the tendency is to an extremely indefinite response or set of responses to a very complex situation, and when the connection's final degree of strength is commonly due to very large contributions from training, it has seemed more appropriate to replace reflex and instinct by some term like capacity, or tendency, or potentiality. Thus an original tendency to respond to the circumstances of school education by achievement in learning the arts and sciences is called the capacity for scholarship.

There is, of course, no gap between reflexes and instincts, or between instincts and the still less describable original tendencies. The fact is that original tendencies range with respect to the nature of the responses from such as are single, simple, definite, uniform within the individual and only slightly variable amongst individuals, to responses that are highly compound, complex, vague, and variable within one individual's life and among individuals. They range with respect to the nature of the situation from simple facts like temperature, oxygen or humidity, to very complex facts like 'meeting suddenly and unexpectedly a large animal when in the dark without human companions,' and include extra-bodily, bodily, and what would be commonly called purely mental, situations. They range with respect to the bond or connection from slight modifiability to great modifiability, and from very close likeness amongst individuals to fairly wide variability.

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[1] Adapted from *The Original Nature of Man*, pp. 5–13. New York: Teachers College, Columbia University, 1920.

Much labor has been spent in trying to make hard and fast distinctions between reflexes and instincts and between instincts and these vaguer predispositions which are here called capacities. It is more useful and more scientific to avoid such distinctions in thought, since in fact there is a continuous gradation.

THE COMPONENTS OF AN ORIGINAL TENDENCY

A typical reflex, or instinct, or capacity, as a whole, includes the ability to be sensitive to a certain situation, the ability to make a certain response, and the existence of a bond or connection whereby that response is made to that situation. For instance, the young chick is sensitive to the absence of other members of his species, is able to peep, and is so organized that the absence of other members of the species makes him peep. But the tendency to be sensitive to a certain situation may exist without the existence of a connection therewith of any further exclusive response, and the tendency to make a certain response may exist without the existence of a connection limiting that response exclusively to any single situation. The three-year-old child is by inborn nature markedly sensitive to the presence and acts of other human beings, but the exact nature of his response varies. The original tendency to cry is very strong, but there is no one situation to which it is exclusively bound.

Original nature seems to decide that the individual will respond somehow to certain situations more often than it decides just what he will do, and to decide that he will make certain responses more often than it decides just when he will make them. So, for convenience in thinking about man's unlearned equipment, this appearance of *multiple response* to one same situation and multiple *causation* of one same response may be taken roughly as the fact.

It must not, however, be taken to mean that the result of an action set up in the sensory neurones by a situation is essentially unpredictable —that, for instance, exactly the same neurone-action (paralleling, let us say, the sight of a dog by a certain two-year-old child) may lead, in the two-year-old, now to the act of crying, at another time to shy retreat, at another to effusive joy, and at still another to curious examination of the newcomer, all regardless of any modification by experience. On the contrary, *in the same organism the same neurone-action will always produce the same results—in the same individual the really* *same situation will always produce the same response.* The apparent existence of an original sensitivity unconnected with any one particular response, so that apparently the same cause produces different results, is to be explained in one of two ways. First, the apparently same situation may really be different. Thus, the sight of a dog to an infant in its mother's arms is not the same situation as the sight of a dog to an infant alone on the doorstep. Being held in its mother's arms is a part of the situation that may account for the response of mild curiosity in the former case and fear in the latter. Second, if the situations are really identical, the apparently same organism really differs. Thus a dog seen by a child, healthy, rested, and calm, may lead to only curiosity, if seen by the same child, ill, fatigued, and nervously irritable, it may lead to fear. The organism may differ by being differently disposed in its sensory apparatus, in its associative or connecting apparatus, in its motor neurones, in its muscular condition, or in other organs concerned in the response. These predispositions may come through conditions of nutrition, poisoning, fatigue, co-operative stimulation, etc., etc.[1]

Similarly, the really same response is never made to different situations by the same organism. When the same response seems to be made to different situations, closer inspection will show that the responses do differ; or that the situations were, in respect to the element that determine the response, identical; or that the organism is itself different. Thus, though 'a ball seen,' 'a tin soldier seen,' and 'a rattle seen' alike provoke 'reaching for,' the *total* responses do differ, the central nervous system being provoked to three different responses manifested as three different sense-impressions—of a ball, of a tin soldier, and of a rattle. Thus, if 'ball grasped,' 'tin soldier grasped,' and 'rattle grasped' alike provoke 'throwing,' it is because only one particular component, common to the three situations, is effective in determining the act. Thus, if a child now weeps whenever spoken to, whereas before he wept only when hurt or scolded, it is because he is now exhausted, excited, or otherwise changed.

The original connections between situation and response are never due to chance in its true sense, but there are many minor cooperating forces by which a current of conduction in the same sensory neurones or receptors may, on different occasions, diverge to produce different results in behavior, and by which very different sensory stimulations may converge to a substantially common consequence.

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[1] Their most potent causes are the effects of previous experience, but these do not concern the present inquiry, since all effects of previous experience are, of course, to be rigorously excluded from a description of original nature.

One may use several useful abstract schemes by which to think of man's original equipment of reflexes, instincts and capacities. Perhaps the most convenient is a series of S-R connections of three types. Some are of the type—S_1 leads to R_1, its peculiar sequent; some are of the type—S_1 leads to R_1 or R_2 or R_3 or R_4 or R_5, etc., according to very minor casual contributory causes; some are of the type—S_1 leads to $R+r_1$, S_2 leads to $R+r_2$, S_3 leads to $R+r_3$, etc., where r_1, r_2, and r_3 are minor results.

Graphically this scheme is represented by Figs. 18, 19, and 20.

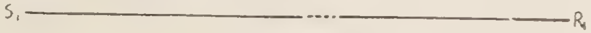

FIG. 18

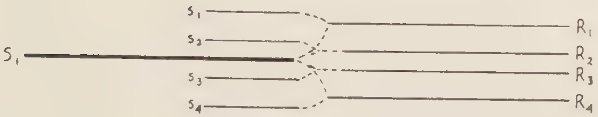

FIG. 19

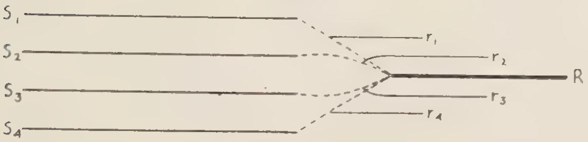

FIG. 20

Besides such a system of tendencies deciding which response any given situation will produce, there are certain tendencies that decide the status of features common to all situation-response connections. There is, for example, in man an original tendency whereby any connection once made tends, other things being equal, to persist. There is also a tendency whereby any connection or response may or may not be in readiness to be made—may be excited to action easily or with difficulty. These tendencies toward the presence or absence of a certain feature in all connections or responses will be examined by themselves in due time.

THE ACTION OF ORIGINAL TENDENCIES

We can imagine a man's life so arranged that one after another original tendency should be called into play, each by itself. Let him be in a certain status, and let, successively, the light grow five times as intense, snuff be blown up his nostrils, a dear friend approach, and the earth quake, without in any case any other changes whatever either in the surroundings or in his internal status. Then the pupils of his eyes would contract, he would sneeze, he would smile, and he would start.

The original tendencies of man, however, rarely act one at a time in isolation one from another. Life apart from learning would not be a simple serial arrangement, over and over, of a hundred or so situations, each a dynamic unit; and of a hundred or so responses, fitted to these situations by a one-to-one correspondence. On the contrary, they cooperate in multitudinous combinations. Their combination may be apparent in behavior, as when the tendencies to look at a bright moving object, to reach for a small object passing a foot away, and to smile at a smiling familiar face combine to make a baby smilingly fixate and reach for the watch which his father swings. Or the combination may take place unobserved in the nervous system, as when a large animal suddenly approaching a solitary child makes him run and hide, though the child in question would neither run nor hide at solitude, at the presence of the animal, or at the sudden approach of objects in general.

It is also the case that any given situation does not act absolutely as a unit, producing either one total response or none at all. Its effect is the total effect of its elements, of which now one, now another may predominate in determining response, according to cooperating forces without and within the man. The action of the situations which move man's original nature is not that of some thousands of keys each of which unlocks one door and does nothing else whatever. Any situation is a complex, producing a complex effect; and so, if attendant circumstances vary, a variable effect. In any case it does, so to speak, what it can.

Ultimately, indeed, every fact in human life is a case of the coaction of all the universe except the man in question, and the condition of the man in question at that instant. In taking anything short of all the universe save him and calling it the situation, we are abstracting —are replacing the total effective situation by some element of it. Also, in taking anything short of the rich entirety of the man at that instant as the organism, we are abstracting—are replacing the total effective conditions of the response by some of their main features. Such abstraction is, of course, the procedure of common sense and of science. Everywhere there is abundant justification for building up an abstract scheme of the responses which situations *a*, *b*, *c* singly evoke, though in fact they never act singly; or of the bonds between situation of *d* and a total set of responses, though in fact the various component elements of *d* are never present in just the same proportions so that the very existence of *d* as a thing by itself is a myth.

EXERCISES

1. Enumerate some of the simpler elements involved in the complex activities of (*a*) eating and (*b*) fighting.
2. Why is it that such activities as eating and fighting never appear twice in exactly the same form?
3. How is it that we are able to identify certain acts as *eating* and certain acts as *fighting* even though there are no two manifestations of either eating or fighting that are just alike?

3. REFLEX ACTION

A[1]

BY HOWARD C. WARREN

In the human adult comparatively few activities belong to the pure reflex type. For the most part our motor impulses are modified by complex central impulses which involve a number of higher arcs. Even such a simple reflex as winking may be reinforced or partly inhibited by central control; and the same motor paths which carry impulses for the winking reflex also conduct impulses for "voluntary" winking and for closing the eye.

Table VI gives the most prominent and important human reflexes. In some cases several allied reflexes are grouped under a single head. The autonomic processes (circulation, breathing, etc.) may be regarded as a continuous succession of reflexes. Since these activities possess no psychological interest they are not included in the table.

TABLE VI

HUMAN REFLEXES

A. PUREST—LEAST SUBJECT TO CENTRAL MODIFICATION IN ADULT

"Pupillary" or iris reflex
Ear twitching (controlled in some individuals)
Hand withdrawal (to heat and pain)
Myenteric reflexes (operation of stomach and intestinal muscles in digestion)
Snoring
Shuddering
Starting (to sudden noise, etc.)
Trembling
Shivering
Rhythmic contractions (in epilepsy, paralysis agitans, etc.)

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[1] Taken from *Human Psychology*, pp. 100–101. Boston: Copyrighted by and taken by permission from Houghton Mifflin Co., 1919.

TABLE VI—*Continued*

B. LARGELY PURE—SUBJECT TO INHIBITION OR REINFORCEMENT

Winking
Accommodation, ciliary reflex
Eye-fixation and convergence
Hiccoughing
Sneezing
Patellar reflex (knee jerk)
Dizziness reflexes
Yawning
Vomiting
Facial reflexes (to bitter taste, etc.)
Salivation
Tickle reflexes
Hand twitching (to dermal pain)
Plantar reflex (to stimulus on sole of foot)
Great toe reflex
Vasomotor changes (blushing, paling)
Breathing changes (to specific stimuli and to onset of sleep)
Sudorific reflexes
Groaning
Laughing
Cramp movements
Squirming

C. OCCASIONALLY PURE, MORE OFTEN CENTRALLY MODIFIED

Coughing
Swallowing and gulping
Visceral discharge, etc.
Functioning of sex organs
Reflexes to odors
Gasping
Weeping
Sobbing
Smiling
Wincing, etc.
Scowling
Stretching
Convulsive contractions (to deep pressure and heat, to pricking and other dermal pains, and to visceral pain)

D. PURE IN INFANCY, CENTRALLY MODIFIED IN ADULT

Sucking
Biting and grinding
Spitting
Hunger and thirst reflexes
Lip and tongue reflexes
Vocal reflexes
Turning the head
Tossing
Grasping (finger reflexes)
Tugging (wrist reflexes)
Clasping (elbow reflexes)
Reaching (shoulder reflexes)
Kicking (knee reflexes)
Stepping (gluteal reflexes)
Jumping (ankle reflexes)
Sitting up
Bending forward
Rising

E. POSTURE REFLEXES

Holding head erect
Sitting
Standing
Equilibration

B[1]

BY WALTER S. HUNTER

Definition of reflexes.—In the topic of reflex action we are to examine the elementary mechanics of behavior. All behavior seems to be a combination, more or less complex, of the relatively simple activities of muscles and glands. Our brief examination is therefore the necessary prologue to the understanding of the more complicated forms of response termed instinct and habit. *A reflex act is a simple inherited mode of response controlled by the nervous system.* This definition rules out all responses of organisms devoid of nervous tissue. Such responses are *tropisms.* It also rules out those responses in animals with nervous systems where the activity is initiated directly by chemical means, as, for example, the case in man where the presence of pancreatic juice in the intestines stimulates the glands there to pour forth their secretions. These cases are also tropisms. The part that is inherited is the synaptic connection which finally determines the nature of behavior. In the case of reflex arcs, the motor neurone of one arc may lead to the muscles that extend the hand, and another motor neurone may lead to flexor muscles of the hand. The sensory neurone, which has synaptic connections with each motor neurone, comes from the skin, where it can be stimulated by an injurious object. When such an object sets up a sensory nervous impulse, this impulse passes immediately out over the former of the two neurones by virtue of the relatively low resistance of this synapse, and the object is dropped. It is this low resistance at the synapse which is inherited. Even in the extremely simple case that we have taken, however, the activity is not confined to one reflex arc. No one reflex arc acts independently of the other reflex arcs. In our present instance, before the hand could be opened (extended), the muscles which closed (flexed) it had to relax. In other words, the sensory impulse not only excited one group of muscles; it also inhibited the antagonistic group. Even the simplest activity therefore involves a co-ordination of reflex arcs. The mechanism of inhibiting the flexor muscle is as much inherited as that for exciting the extensor muscle. It is primarily for this reason that no sharp distinction can be drawn between reflex action and instinct.

The reader should not infer from the preceding description that all reflexes occur through the spinal cord. The brain is particularly rich in reflex centers.

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[1] Adapted from *Human Behavior*, pp. 175–82 (revised edition). Chicago: University of Chicago Press, 1928.

Types of reflexes.—Reflexes may be classed as *conditioned* and *unconditioned* upon the basis of the presence or absence of the effects of training. Two other types of classification remain to be mentioned here. *Allied* and *antagonistic* reflexes constitute one of these classes. Allied reflexes are those which occur simultaneously and which facilitate each other. A dog starting to scratch, e.g., must shift his weight to three legs. The reflexes so involved are allied in relation to the scratch reflex. Antagonistic reflexes are those which cannot occur simultaneously and which inhibit each other. Walking and running are two such cases, inasmuch as they involve mutually incompatible forms of behavior. The activities of paired flexor and extensor muscles form another example. One cannot extend the fingers at the same time that he is closing them. In such cases the activity of the flexor group involves an inhibition of the extensor group, and vice versa. The remaining type of classification divides reflexes into those which are complicated with verbal responses and those which are not. The former group are, typically, reflexes controlled by the cerebro-spinal system. The latter group are, typically, reflexes controlled by the sympathetic nervous system. *Verbally complicated reflexes* are those which through training are, or may be, accompanied by verbal responses. The knee-jerk, the wink, sneezing, and swallowing are examples of verbally complicated reflexes. The sensory nervous impulses set up in these reflexes may cause contractions in the vocal musculature. Verbal responses often produce sounds which result in nervous impulses from the ear, and they always result in kinaesthetic nervous impulses from the vocal musculature. In the verbally complicated reflexes either the auditory or the kinaesthetic impulses set up by the verbal response may arouse the reflex. *Verbally non-complicated reflexes* are those reflexes which cannot arouse verbal responses, even after training, and which cannot, in their turn, be aroused by the immediate and direct sensory consequences of the verbal responses. To this class belong such reflexes as glandular secretions, activities of the iris and ciliary muscles of the eyes, and the contractions of the heart muscles.

Figure 21 presents a diagram as an aid to the understanding of the verbally complicated and the verbally non-complicated reflexes. We shall use the knee-jerk for purposes of illustration. A stimulus applied to the receptor, *R*, sends impulses across neurone 1 to the effector at *E*. The contraction of the effector stimulates receptors in the effector, and a nervous impulse passes over neurones 3, 4, and 5 to the vocal effectors, *Ve*. When these effectors are thrown into activity, the receptors which lie in them are stimulated, and nervous impulses pass over neurones 6 and 7 and so over neurone 2, with the consequent arousal of the effector, *E*. If the activity of the effector, *Ve*, makes a sound, the ear, *Ea*, is stimulated and nervous impulses pass over neurones 8 and 9. The activity of the verbally complicated reflex differs from the situation in the conditioned reflex by the

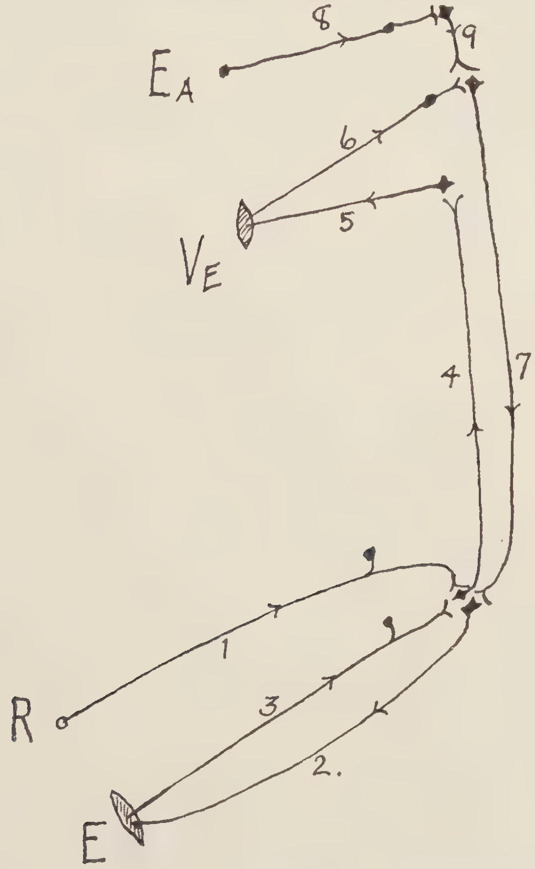

Fig. 21.—A schematic diagram of verbally complicated and verbally non-complicated reflexes. The figure is described in the text.

presence of neurones 3, 4, and 5. In a conditioned reflex it is essential that a new stimulus arouse the old response. This is shown in Figure 21 by the afferent pathway, 6 and 7, from *Ve*. When *E* is active as a result of impulses from *Ve*, the response is again a conditioned reflex. In a verbally complicated reflex, the reflex activity arouses a verbal response. Reflexes of the type of the heartbeat, although they arouse afferent impulses, do not send these afferent impulses to the vocal musculature, nor can they be trained to do so. These reflexes are, therefore, classified as verbally non-complicated.

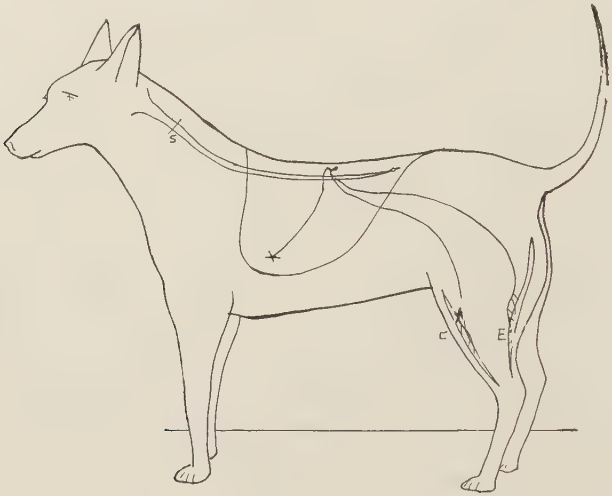

FIG. 22.—A spinal dog. The figure also indicates reflex arcs from the point *x* in the saddle-shaped area to the flexor (*F*) and extensor (*E*) muscles of the dog. The approximate location of the spinal section is shown in the cervical region (*S*).

Typical phenomena in reflex action.—Most of the experimental data that we have on the simpler reflexes come from a study of spinal animals. A spinal dog, e.g., is one whose spinal cord has been transected, or cut across, just below the medulla, thus freeing the reflex activities controlled by the cord from the influence of the brain. In animals like the dog the reflex functions of the cord persist unimpaired by the operation. In the dog the scratch reflex has been most thoroughly studied (Sherrington). If any point in the saddle-shaped area of the spinal dog shown in Figure 22 is stimulated, the hind leg on that side is alternately flexed and extended in the typical scratch activity. Only allied harmonious reflexes are active at any one moment. The rate of this reflex is constant (4.5 beats per second) no matter what the intensity of the stimulus. The scratch rhythm proceeds practically unmodified by variation of the rhythm of the stimulation of the skin. This partly depends on the fact that each reflex has a *refractory period* during which, even apart from fatigue, it cannot be fully re-excited. The refractory phase is very similar to inhibition, and in the case of the scratch reflex depends upon changes in the central portion of the reflex arc. If the intensity of the stated stimulus is gradually increased, the phenomenon of *spread* occurs, i.e., more and more reflexes are aroused, due to the irradiation of the nervous impulses in the cord, until the whole dog is active. Furthermore, if two points of the saddle-shaped area are stimulated simultaneously, each stimulus by itself being too weak to arouse a response, the reflex will nevertheless appear as a result of the *summation* of the nervous impulses. Other additional facts have been brought out that are of importance in securing a comprehensive view of the behavior mechanism. Each reflex, for instance, has a *latent time*, i.e., a period intervening between the application of the stimulus and the appearance of the response. The length of this latent time will vary from 0.002 to 0.2 second, depending on the intensity of the stimulation. Sherrington has found that a reflex arc is just as ready to conduct, i.e., that it responds as quickly, when it is inactive as when it is active at the moment of stimulation. *Fatigue* also influences reflex activity. Again, other things being equal, the protective reflexes—those aroused by injurious, noxious stimuli—have the *right of way* over other reflexes. At any one moment, for example, contact with the floor tends to arouse the reflexes in the dog which give him his upright position. A painful stimulus, breaking upon this, immediately gets control of the muscles of the leg and produces a protective reflex activity.

Two of the most important phenomena of reflex action are *facilitation* and *inhibition*. Sometimes nervous impulses facilitate, help, each other, and sometimes the relationship is one of inhibition, hindrance. Yerkes, e.g., found that he could secure a muscular contraction in a frog's leg by tapping the frog smartly on the back of the neck. When an auditory stimulus was given with the tap, the contraction of the leg muscles was greater. Inhibition is excellently shown in the reciprocal activity of antagonistic muscles. The activity of flexor muscles, e.g., is accompanied by an inhibition of the extensors, and vice versa. The mechanism underlying facilitation and inhibition is not clearly understood, although examples of the phenomena are numerous. The cerebral cortex exercises a marked inhibitory effect upon the lower nerve-centers, and by so doing contributes to the regulation of behavior.

Certain synaptic connections leading to the effectors are more open than others by virtue of inheritance, while practice within the lifetime of the individual reduces the resistance of other connections. These conditions governing behavior are relatively permanent over long periods of time, while the factors listed in the foregoing paragraphs, and certain of the facilitatory and inhibitory conditions, with the exception of "right of way," vary from moment to moment. This is essentially true also to the extent that behavior is partially determined by the behavior which has preceded, for "preceding behavior" is always a variable and indeterminate factor.

Resulting view of behavior.—On the basis of these observations, how are we to describe the behavior of the dog or other animal at any one moment? Each animal has a definite limited number of muscles supplied by a limited number of motor nerves. All types of behavior, all forms of action, must use this single motor system. At any one moment eyes, ears, nose, and skin are sending sensory impulses in to the central nervous system. Here they must compete for the control of the motor system. Which impulse shall win out will depend partly upon the interrelation of the factors we have just mentioned: refractory period, spread, summation of stimuli, latent time, fatigue, inhibition and facilitation, and the "right of way." A slight variation in any one of these factors may be sufficient to give control of the muscles to the eyes as opposed to the ears. This selection and determination of behavior are finally decided at the synapse on the basis of varying resistances to the passage of competing nervous impulses. This determination of behavior by synaptic connections we shall find exemplified in our present topic, instinct.

EXERCISE

1. How does it happen that during life certain reflexes are more subject to modification than others?

4. THE CONDITIONED REFLEX[1]

BY THEODORE HOUGH AND WILLIAM T. SEDGWICK

There can be no doubt that many of these reflex mechanisms are born with us. A new born baby, for example, like the adult, winks and secretes tears when the cornea dries; it secretes saliva when a sapid substance is placed in the mouth; it swallows when something touches the throat; if a cane is brought in contact with the palm of the hand, it is grasped firmly. These and many other reflex actions take place from the first because the baby inherits and hence is born with the complete reflex mechanism for their execution upon the application of the appropriate stimuli.

On the other hand, new involuntary reactions can be acquired in adult life, even reactions which are useless to the body. The extent to which this is true is illustrated by the following extreme case: if a piece of ice is applied to a definite spot of the skin, the amount of blood flowing through that part of the skin is greatly diminished and the skin becomes pale. This is an inherited reflex which protects the body from exposure to cold. A morsel of food placed on the tongue (where it stimulates the afferent nerves of taste) will reflexly excite the flow of saliva. In both cases we see the obvious purposeful relation between the stimulus and the reaction and in both cases we are dealing with inherited reflexes. Moreover, these two reflex mechanisms as inherited are entirely independent of each other, for the stimulation of the skin by ice does not excite the flow of saliva nor does the stimulation of the sense of taste influence the blood flow through the skin. If, however, every time that one eats, a piece of ice is applied to the same region of skin, so that *both these reflexes are simultaneously excited*, in the course of two weeks or more it will be found that the application of ice to the skin *excites a flow of saliva even though no food is taken into the mouth.* In other words, these two reflex mechanisms have become *associated*, so that activity of the one now discharges the other. Evidently some sort of nervous connection has been established between them. Fig. 23 gives a diagram of the new association which has been established between the two centers.

The connection thus newly established between the afferent neurones of cold (*c*) and the efferent neurones to the salivary glands (*s*) differs in several ways from the connection between the afferent and efferent sides of an inherited nervous mechanism. Such acquired reactions are not evoked with the same certainty as the inherited and, once acquired, they are more readily lost by disuse. Whether we get the reaction or not depends upon the condition of the body at the time we apply the stimulus. Hence they are spoken of as *conditioned reflexes*, to distinguish them from the *unconditioned* (or inherited) *reflexes*. Undoubtedly many of our involuntary actions, especially acquired habits in general, are conditioned reflexes acquired since birth and thus added on to the stock of inherited reflexes which make part of the equipment with which we begin life.

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[1] Taken from *The Human Mechanism*, pp. 85–87. Boston: Ginn & Co., 1918.

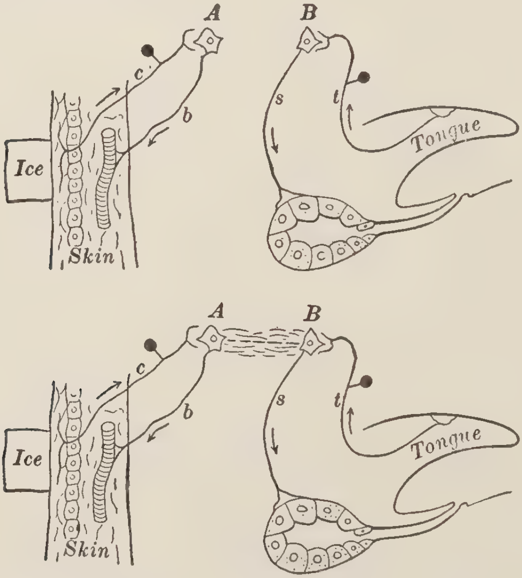

FIG. 23.—The acquisition of a conditioned reflex. *A*, reflex mechanism for constriction of cutaneous vessels when cold is applied to the skin; *B*, reflex mechanism of the secretion of saliva when a sapid substance comes in contact with the tongue. Above is shown the usual normal condition with no connection between the two mechanisms; below, the condition after both have been repeatedly in simultaneous action.

EXERCISE

1. It has been said that in early infancy fear reactions occur only in a few situations, e.g., where there is a loud sound, or lack of bodily support. Cite an actual or hypothetical instance illustrating how fear reactions might be conditioned.

5. VARYING CONCEPTIONS OF INSTINCTS

A. Professor McDougall's Classification of the Human Instincts[1]

Professor McDougall in his famous work, *Social Psychology*, claims that certain very definable innate or inherited tendencies lie at the basis of human character. These are (1) certain specific tendencies or instincts, and (2) certain general or non-specific tendencies arising out of the nature of mind.

Seven of these specific tendencies or instincts are coupled with special emotions. The following table shows these relationships.

Instinct	Emotion
Flight	Fear
Repulsion	Disgust
Curiosity	Wonder
Pugnacity	Anger
Self-abasement (subjection)	Subjection (negative self-feeling)
Self-assertion (self-display)	Elation (positive self-feeling)
Parental instinct	The "tender emotion"

There are certain other instincts which, according to McDougall's theory, are not coupled so definitely with certain emotions, but which are nevertheless of first-rate importance. They are: reproduction, gregariousness, acquisition, and construction.

Some of the general tendencies which are like instincts in being innate, but unlike them in being far less definite, are: sympathy, suggestion, imitation, and play.

B. Bases of Classification[2]

BY KNIGHT DUNLAP

The drawing up and discussing of lists of "instincts" is interesting, and may be useful, if we remember that the classifications are: (1) teleological, that is, determined by the ends or results of reactions, as these ends are discriminated, not by the animal itself, but by the classifier. The "instincts" are not strictly psychological nor physiological systems. (2) That the division into "instincts" is arbitrary, and that any classification which is based on real "ends," and which suits the purposes of our discussion, is as legitimate as any other. It is precisely like a filing system for documents: the system to be adopted is the one which makes reference convenient, and what is convenient for one purpose may be inconvenient for another. "Instincts" cannot legitimately be made the basis for "systems" of social psychology, or for any other theoretical constructions.

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[1] Many attempts have been made to state just what are the instinctive activities of man. That of Professor McDougall is fairly representative, and it is one of the best known.

[2] Taken from *The Elements of Scientific Psychology*, pp. 218–19. St. Louis: C. V. Mosby Co., 1922.

The fact that "instincts" are arbitrary groups, made for the logical purposes of the classifier, is made evident from the appearance of the same reaction in several "instincts" at once. The wolf, or the human animal, in pursuing game, may be exhibiting the "hunting instinct," the "acquisitive instinct," the "self preservative instinct" (since the food derived from the game will sustain his life), the "paternal instinct" (since the production and protection of his progeny depend upon the securing of food for himself, as well as for them), and even the "gregarious" and "self preservative" instincts.

Any given instinctive physiological and psychological reaction may be, at different times, a part of any of the "instincts" in such a list as McDougall's. Fighting may be combat for life itself against an active attack. It may be a struggle for food. It may be a struggle for a female (or on the part of a female for a male) in pursuance of the instinct of sex gratification. It may be combat for a female, but in pursuance of the tendency to beget. It may be in defence of progeny. It may be directed to "gregarious" ends, in the case of an animal or a man who is threatened with expulsion from, or ostracism in, a herd or social group. It may be in performance of an acknowledged leader's command, in direct self-abasement toward the leader. Or it may be a means of self-assertion. It may be a means toward "acquisition," or a form of play.

So with running, hiding, and practically all the definite complex reactions of which the animal is capable. The particular "instinct" the reaction expresses is in part dependent upon circumstances of the actual reaction, but in large part on the whim of the one who classifies it. This must always be borne in mind in considering "instincts." The more useful course is to consider instinctive reaction psychologically, that is, as definite reactions to definite stimuli, and in connection with the desires and other emotional states of the animal which reacts.

EXERCISE

1. Upon what basis or bases has McDougall classified instinctive activities?
2. State some of the conditions necessary for a really accurate enumeration of human instincts.

C. Definitions of Instinct[1]

BY HARVEY A. CARR

The earlier conceptions contrasted instinct with reason. Rational activities are products of experience, and involve some knowledge of their adaptive significance; they are practically identical with what we have termed voluntary activity. Instinctive activities on the other hand are innately conditioned and function automatically. The conception has two defects: Acquired acts may become so habitual as to function in an automatic fashion, while a person will soon acquire some sort of knowledge of the adaptive significance of his instinctive acts.

According to a very prevalent conception, an instinct is defined as an adaptive act, the first expression of which did not involve any knowledge of its consequences; an instinct is thus regarded as a chain or series of reflexes whose serial organization is a function of congenital conditions. A reflex is defined as a motor response to a sensory stimulus in which the connection between the stimulus and the response is mediated by innate neural conditions. An instinct thus consists of an *inherited* co-ordination of a number of elemental reflexes in which each response constitutes or furnishes the stimulus for the succeeding response. No complex activity that is adapted to an objective situation can be instinctive according to this definition.

An organism must *sense* an objective situation and respond to those sensory stimuli in order to adapt to that situation. It thus follows that in reacting to a situation the reflexes that are evoked and the order of their appearance will necessarily be determined in large measure by the character of that situation and not by any congenital conditions of the organism. For example, a rat is confronted by a latch-box containing food. The wire door of this box is electrically charged and its wooden sides are banked with sawdust. The rat at first responds to the odor by running toward the food and coming into contact with the wire door. The resultant electrical shock evokes an avoiding reflex and the animal explores along one side of the box and comes in contact with the sawdust. This contact stimulus now elicits the burrowing reaction which is continued until the hard floor is reached, and this stimulus now evokes a new response. The presence of the sawdust was necessary to elicit the digging response, and it is quite apparent that the order in which such a series of reflexes is evoked will depend in large part upon the spatial arrangement of the stimulating objects.

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[1] Adapted from *Psychology a Study of Mental Activity*, pp. 380–84. New York: Longmans, Green & Co., 1925.

The courting and mating activities of the male pigeon consist of a great variety of reflexive responses such as bowing, cooing, preening, wagging wings, spreading tail feathers, strutting, pecking, billing, necking, and charging and driving. It has been observed that not all of these reflexes will appear unless the female is responsive and that the order of their appearance depends upon the character of her reactions. The order in which reflexes are evoked thus depends for the most part upon environmental circumstances. The stimuli involved in any instinctive series of reflexes, *i.e.*, a series in which the order of appearance is determined by conditions inherent in the organism, must be for the most part *intraorganic* sensations, as in the case of the chewing and swallowing responses that are evoked by the presence of food in the mouth. Organized series of reflexes of this sort constitute but a small part of man's repertoire of reactions.

A third conception regards as instinctive any adaptive reaction which is composed entirely of these congenital reflexes. The order in which these reflexes appear is regarded as unimportant. The order of appearance may thus vary with environmental circumstances as in the case of the nest-building and mating activities of birds. According to this conception, general attributes of specific acts like pugnacity, aggressiveness and perseverance cannot be instinctive although they may be natively conditioned. Such attributes are not instincts because they cannot be resolved or analyzed into a co-ordinated group or series of reflexes. Perseverance is not an act but a characteristic of a great variety of acts. It is the act itself and not its attributive characteristic that is composed of sensorimotor elements. Strictly speaking, man exhibits no instinctive reactions according to this definition, for it is now generally admitted that every adaptive response in man necessarily comprises a considerable number of acquired constituents. Those that subscribe to this belief may be grouped into three classes. First, there are those who adhere to the definition and hence deny the existence of human instincts—an attitude which in no way disposes of the fundamental problems as to the extent to which the nature of a man's acts is a function of his native constitution. Others apply the term "instinct" to all adjustive activities which are composed in the main of reflex elements, and use the term "habit" to refer to all acts which consist wholly or mainly of acquired elements. The distinction between habits and instincts is thus largely a matter of personal opinion. Finally, there are those who adopt a radically different conception of the nature of instinct.

In the final view, just mentioned, the term "instinct" is not applied to acts. It is used to refer to certain native conditions within the organism which specifically determine the character of its reactions. Each instinct thus reveals or manifests itself through a corresponding act or group of acts and the adjective "instinctive" is usually employed to refer to these acts. Expressions of maternal love are instinctive reactions which are due to a maternal instinct. An instinct is thus a hypothetical set of conditions whose existence is assumed in order to give an adequate genetic account of certain observable characteristics of human behavior. Adherents of this view differ considerably as to the nature of these congenital conditions. To some, instincts are merely neural propensities. Others apparently identify instincts with the various innate motivating conditions such as the bodily appetites of hunger and sex. Instinct, to others, includes all those bodily conditions which we have listed under the term of native preferences and propensities. Popular writers often employ the term to refer to any set of native conditions, *capacities* as well as propensities. Such writers are accustomed to assert that, although we undoubtedly learn to walk, yet the capacity to walk is instinctive or born within us. With such a conception, it is evident that all human reactions including thinking, reasoning, and will are instinctive, for no one can perform an act unless he is born with the capacity to do so. With such a usage, the term loses all of its distinctive value. Finally, one writer has recently asserted that there is but one instinct, and apparently this instinct is the life process itself. What aspects of human behavior are regarded as instinctive will thus depend upon the way we define the term "instinct."

EXERCISE

1. Upon what basis or bases has McDougall classified instinctive activities?
2. State some of the conditions necessary for a really accurate enumeration of human instincts.

6. THE RELATION BETWEEN EMOTION AND INSTINCT[1]

BY WILLIAM MC DOUGALL

In order to understand these complications of instinctive behaviour we must submit the conception of an instinct to a more minute analysis. Every instinctive process has the three aspects of all mental process, the cognitive, the affective, and the conative. Now, the innate psycho-physical disposition, which is an instinct, may be regarded as consisting of three corresponding parts, an afferent, a central, and a motor or efferent part, whose activities are the cognitive, the affective, and the conative features respectively of the total instinctive process. The afferent or receptive part of the total disposition is some organised group of nervous elements or neurones that is specially adapted to receive and to elaborate the impulses initiated in the sense-organ by the native object of the instinct; its constitution and activities determine the sensory content of the psycho-physical process. From the afferent part the excitement spreads over to the central part of the disposition; the constitution of this part determines in the main the distribution of the nervous impulses, especially of the impulses that descend to modify the working of the visceral organs, the heart, lungs, blood-vessels, glands, and so forth, in the manner required for the most effective execution of the instinctive action; the nervous activities of this central part are the correlates of the affective or emotional aspect or feature of the total psychical process. The excitement of the efferent or motor part reaches it by way of the central part; its constitution determines the distribution of impulses to the muscles of the skeletal system by which the instinctive action is effected, and its nervous activities are the correlates of the conative element of the psychical process, of the felt impulse to action.

Now, the afferent or receptive part and the efferent or motor part are capable of being greatly modified, independently of one another and of the central part, in the course of the life history of the individual; while the central part persists throughout life as the essential unchanging nucleus of the disposition. Hence in man, whose intelligence and adaptability are so great, the afferent and efferent parts of each instinctive disposition are liable to many modifications, while the central part alone remains unmodified: that is to say, the cognitive processes through which any instinctive process may be initiated exhibit a great complication and variety; and the actual bodily movements by which the instinctive process achieves its end may be complicated to an indefinitely great extent; while the emotional excitement, with the accompanying nervous activities of the central part of the disposition, is the only part of the total instinctive process that retains its specific character and remains common to all individuals and all situations in which the instinct is excited. It is for this reason that authors have commonly treated of the instinctive actions of animals on the one hand, and of the emotions of men on the other hand, as distinct types of mental process, failing to see that each kind of emotional excitement is always an indication of, and the most constant feature of, some instinctive process.

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[1] Adapted from *An Introduction to Social Psychology*, pp. 32–34. Boston: John W. Luce & Co., 1914.

EXERCISE

1. Name an emotion which is excited by an object or situation which did not formerly excite it, and which results in behavior in which it did not formerly result.

7. EFFECTS OF PRACTICE ON INSTINCTS

A. The Modification of Instinct[1]

BY WALTER S. HUNTER

Shortly after birth an individual will, through heredity, manifest the fear reaction upon the presentation of certain stimuli. By virtue of associations, these stimuli may later become ineffective and new stimuli be secured which were previously indifferent. Thus birds on desert islands show no fear of man until the frequency of his appearance, coupled with effective stimuli for fear, finally endows the perception of man himself with the capacity to arouse fear. Studies of the conditioned reflex are laboratory observations of this same phenomenon. The protective reflex of the finger, *e.g.*, has as its unconditioned (inherited) stimulus injury to the finger; but by a frequent simultaneous presentation of sound and injury, sound also becomes an effective stimulus producing withdrawal of the finger. The internal mechanism of this need not concern us in the present discussion. It should be stated, however, that habits as well as inherited forms of response are susceptible to this type of modification, the distinction being that we deal with conditioned reflexes directly when the changes effected are made from the original stimulus rather than from stimuli which in themselves may be one or more removes from the hereditary status of the response.

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[1] Taken from "The Standpoint of Social Psychology," *Psychological Review*, XXVII (1920), 248–50.

From the side of changes in effector activities proper, the same statements are true although the term conditioned reflex seems not to have attached to such modifications, undoubtedly due to the accident governing the choice of laboratory procedure. The protective reflex and the salivary reflex, *i.e.*, the effector activities proper, have been kept constant in such studies and experimentation directed toward the analysis of stimulus changes. However the physiological changes effected are presumably no different from those which occur in the contrary case when experience changes the type of response while the stimulus remains constant. The illustrations of this are legion. One may cite the changes which occur in the "expression" of fear and anger as the human individual matures in a social environment, or one may consider the modifications which occur in animal behavior during the process of learning. In the latter case, a total situation is presented to a white rat placed in a visual discrimination box, calling forth exploratory movements; but under the influence of punishment, reward, and frequency, the exploratory movements are inhibited and give way to well-defined food responses. One may state such an outcome either as the inhibition of an instinctive response to a given stimulus by acquired responses, or as the acquisition by the food-getting response of a new stimulus. Perhaps both are involved.

The social values of the above types of change in instinct have been so widely recognized that we need not elaborate the problem further. This is not true, however, in the case of those modifications termed sublimations. The sublimation of instinct in the human individual is an example of the simultaneous modification of the afferent and efferent phases of the response. Anger becomes righteous indignation by the substitution of a new and (in this case) an ideal stimulus for the sensory (animal) one and by the conversion of the gross bodily attack into the response of denunciation, purchasing Liberty Bonds, or longer hours of labor. Sex impulses may be sublimated in artistic activity, in dancing, in religious activity, or, when joined possibly with the parental impulse, in social service. Instances of sublimation are those where the inherited impulses are placed at the service of activities which bear little or no resemblance to the activity which normally embodies the impulse. The cases are not due to the suppression or elimination of the instinct in its entirety; only the somatic, skeletal responses are inhibited while the visceral continue probably at full intensity. The individual may entirely fail, and usually does fail, to identify the persistent behavior complex, because to the uninitiated, instincts are identified in terms of their somatic components. *It is this difficulty of identification which permits the sublimation to proceed unimpeded by emotional conflict, and unthreatened by the failure which would almost surely be its lot did the subject realize the origin of his impulses in their proper* (*unconditioned*) *instinct.*

Although the non-technical use of sublimate means to purify, or to idealize, the preceding analysis would indicate that the physiological mechanisms involved need not include the equivalent of ideals. The stimuli for artistic activities, for dancing, for charity and social service may be as concrete as for the arousal of any other form of modified instinctive performance. The presence of syncopated music and members of the opposite sex initiates dancing, and the awareness of suffering and poverty calls out charitable relief in those individuals possessing the sublimated behavior. And so, although one would hesitate to apply this term to animals below man, the understanding of instinctive modifications is better when one realizes the essential continuity of the phenomena. Thus a dog can by training be made angry by whistling, and the instinct can then be modified on its effector side by training the dog to vent his pugnacity in some unusual manner. Behavioristically, the instinct is as truly sublimated as in man, although the social significance of the change may be infinitesimal.

B. Some Experimental Studies of Instinct[1]

BY WALTER S. HUNTER

Practically all studies of instincts, in the popular sense of that term, have been made upon infrahuman animals. (We should not forget, however, that breathing and circulation are instincts in the technical sense of that term, and that these have been extensively studied in man.) There are two chief reasons for this: (1) animals are more readily controlled from birth, and so make more convenient study material, and (2) man's responses are so deeply influenced by custom and habit that it is a rare instance when an instinctive response breaks through in anything like its original form and vigor. This fact has given rise to two contradictory statements. One is that man has more instincts than animals and that their interference is what gives the highly varied aspect to his behavior. The other is that man has no instincts in the true sense of the word. The former view is probably much nearer the truth.

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[1] Adapted from *Human Behavior*, pp. 183–89. Chicago: University of Chicago Press, 1928.

1. *The pecking of chicks.*—A good example of this experimental work is the analysis of the pecking instincts in chicks, published in 1911 by Breed. He undertook the problem in order to determine from the study of a simple, easily controlled response how perfect a particular instinct is at its first appearance and just how much development takes place after the first performance. The pecking response (the terminology of Spalding and Morgan being followed) was divided into three parts; striking, seizing, and swallowing. The chicks were hatched in an incubator and then kept in a dark basket to the beginning of the tests. After the first day's test the chicks were returned to the lighted brooder, from which they were taken each subsequent day for a test of their proficiency at that time. For the test the chick was placed upon a smooth black table-top upon which were a few grains of food. In pecking the chick might miss the grain; or strike it, but not seize it; or seize it, but not swallow it; or success might crown its efforts and the grain be swallowed. Fifty trials were given each day. Figure 24 shows how the chicks progressed from day to day. Curve 1 represents the decrease in errors of striking with increase in age of the chick. Curves 2 and 3 indicate similar decreases for errors in seizing and swallowing, respectively. Curve 4 shows the increase in the number of perfect responses as the chick increases in age. We may thus see graphically that the chicks, starting out with only 15 per cent of the responses perfect, reached an average of 84 per cent. Not all of this increase in efficiency, however, is to be credited to practice, or habit, as one might suppose at first thought. Undoubtedly as the chick grows older there is a maturation, not only of the bodily structure in general, but also of the nerve centers (synaptic connections) which control the instinct, so that a part of the increase in efficiency is due to the growth of the instinct as a result of strictly inherited tendencies.

Studies made by Shepard and Breed, Bird, and Moseley on chicks whose pecking has been artificially delayed throw light upon this problem. Figure 25 shows the results secured by Shepard and Breed. Chicks were kept from pecking for various intervals, some for three days, some for four days, and some for five days, and were then tested. During the delay they were fed artificially. All of the curves for these delayed chicks began below the normal curve, but caught up with this normal curve after two days' training. Although the number of subjects used was too small to make the curves reliable as representative curves for the conditions studied, the conclusion that maturation has made possible the rapid initial rise is very strongly suggested.

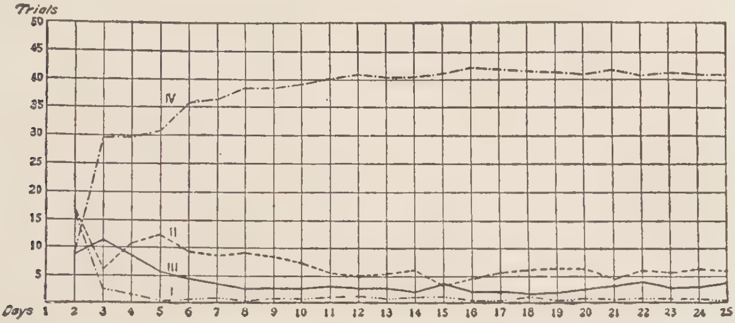

FIG. 24.—Graphic records of data secured by Breed in his study of the pecking instinct of chicks. The figure is described in the text.

Moseley, working with a much larger number of chicks, secured results on delayed animals quite different from those of Shepard and Breed. The curves for her results are shown in Figure 26. There is good reason for believing that the slow improvement of the delayed chicks was due to the interference of habits established during the period of artificial feeding.

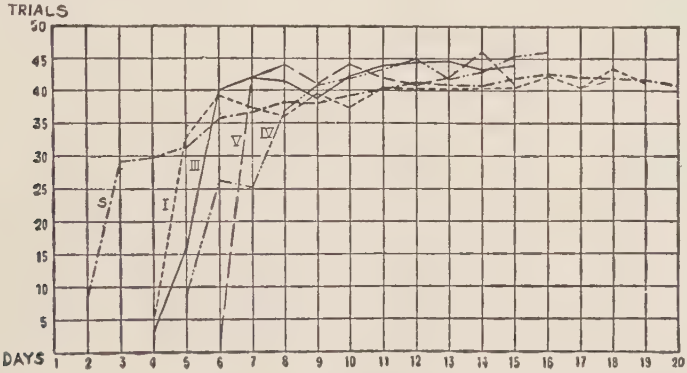

FIG. 25.—The development of the pecking instinct with normal conditions (*S*) and after delays of 3 days (I and III), after 4 days (IV), and after 5 days (V), *S* is based upon 21 chicks; I, upon 4; III, upon 6; IV, upon 3; and V, upon 1 (from Shepard and Breed).

Bird has secured results which indicate that maturation will not enable the chick to reach normal accuracy if the number of pecks per day is limited to twenty-five. Under these conditions the chicks improve normally for a few days, and then the records remain about constant until the amount of practice is greatly increased, whereupon the curves again rise until the reactions of normal chicks are approximated. Bird has also compared chicks tested eight hours after hatching and again when twenty-four hours old with chicks that pecked only after they were twenty-four hours old. In each case the better records were made by the older groups of subjects.

It seems possible to conclude from the various studies that the improvement of pecking behavior is accomplished partly by practice and partly by a maturation, which may be either a general physiological development or a specific growth of nerve centers, or both. This rôle of maturation may be blocked by interfering habits, as indicated in Moseley's work.

Carmichael has secured evidence bearing upon the rôle of maturation through the study of the swimming movements of the embryos of *Amblystoma punctatum*. Coghill has carefully worked out the reflex arcs which control these swimming movements and has correlated the appearance of these movements with the neural development, and Carmichael followed up this work by placing embryos in an anaesthetizing solution and allowing them to develop under conditions where they could not respond to external stimulation and where they made no responses. These anaesthetized animals were then placed in fresh water, and allowed to recover, after they had reached an age when normal embryos would be manifesting swimming movements. After recovery the animals respond to stimulation. We are, therefore, justified in concluding that the reflex mechanisms had developed in the animals without being influenced by external stimuli or by practice. Maturation and practice in the normal animal go hand in hand, but it is possible under experimental conditions to allow maturation to play the major rôle in the determination of behavior.

2. *The instinct of vocalization in birds.*—Studies by Yerkes and Bloomfield on the instinct to kill in kittens have indicated that certain inherited synaptic connections function independently of imitation and social example. In the following study by Conradi (1905), on the other hand, we find an equally certain case of instinctive activity and an equally certain influence of social factors (the stimulation of the bird by the songs of its associates) on the development of this activity. From this study and from that of Scott and Witchell it seems certain, moreover, that the call notes of birds are the primitive vocalizations,

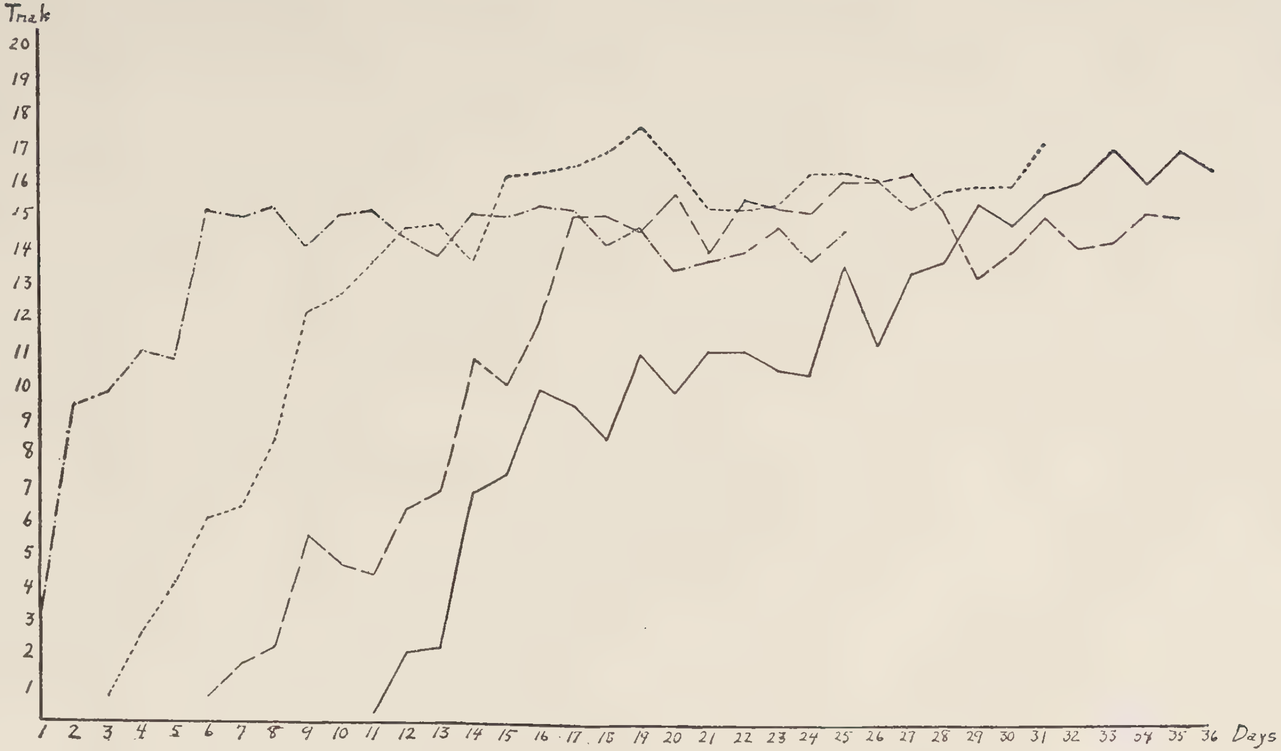

FIG. 26—Curves for response 4 in the normal, the three days' delay, the six days' delay, and the eleven days' delay groups (after Moseley).

and are more uniformly inherited than the tendency to sing, which is present in addition in many birds. The mechanisms for vocalization are inherited, but the manner in which they shall function is determined largely by environment. This is illustrated by the fact ascertained by Scott that Baltimore orioles when kept alone and free from other birds developed a novel song of their own rather than the song characteristic of their species. Conradi's work illustrates the same point. He secured some young sparrows from the wild and placed them either under the care of a mother canary or in the room with canaries. Some developed the sparrow call note, and in addition all learned more or less thoroughly the songs of the canaries with whom alone they all associated. I may quote one observation:

> On September 26, when the sparrow was a little over three months old, he was for the first time observed to give a trill. It was short and musical and was given a number of times in succession. These short trills were at first only rare but they increased in frequency during the year. When he gave them he would sit still on his perch and give them one after another very modestly. Now (Dec., 1904) he gives short trills interspersed with other notes, punctuating the whole by turning complete circles and semicircles on his perch.
>
> None of these sparrows ever had the characteristic call note of the wild species, but by and by adopted those of the canary. They imitated the canary perfectly except that their voice did not have the musical finish.[1]

When removed from the canary environment they soon lost the canary song, but reacquired it on being again placed with those birds.

EXERCISE

1. Discuss the relationship between the indefiniteness of human instincts and the breadth of human capacity.

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[1] E. Conradi, "Song and Call Notes of English Sparrows when Reared by Canaries," *Amer. Jour. Psych.*, XVI (1905), 197.

CHAPTER V

HABIT

1. THE CONCEPT OF MODIFIABILITY

A[1]

BY H. S. JENNINGS

Introductory

Everywhere in the study of life processes we meet the puzzle of regulation. Organisms do those things that advance their welfare. If the environment changes, the organism changes to meet the new conditions. If the mammal is heated from without, it cools from within; if it is cooled from without, it heats from within, maintaining the temperature that is to its advantage. The dog which is fed a starch diet produces digestive juices rich in enzymes that digest starch; while under a diet of meat it produces juices rich in proteid-digesting substances. When a poison is injected into a mouse, the mouse produces substances which neutralize this poison. If a part of the organism is injured, a rearrangement of material follows till the injury is repaired. If a part is removed, it is restored, or the wound is at least closed up and healed, so that the life processes may continue without disturbance. Regulation constitutes perhaps the greatest problem of life. How can the organism thus provide for its own needs? To put the question in the popular form, How does it know what to do when a difficulty arises? It seems to work toward a definite purpose. In other words, the final result of its action seems to be present in some way at the beginning, determining what the action shall be. In this the action of living things appears to contrast with that of things inorganic. It is regulation of this character that has given rise to theories of vitalism. The principles controlling the life processes are held by these theories to be of a character essentially different from anything found in the inorganic world. This view has found recent expression in the works of Driesch (1901, 1903).

Regulation in Behavior

Nowhere is regulation more striking than in behavior. Indeed, the processes in this field have long served as the prototype for regulatory action. The organism moves and reacts in ways that are advantageous to it. If it gets into hot water, it takes measures to get out again, and the same is true if it gets into excessively cold water. If it enters an injurious chemical solution, it at once changes its behavior and escapes. If it lacks material for its metabolic processes, it sets in operation movements which secure such material. If it lacks oxygen for respiration, it moves to a region where oxygen is found. If it is injured, it flees to safer regions. In innumerable details it does those things that are good for it. It is plain that behavior depends largely on the needs of the organism, and is of such a nature as to satisfy these needs. In other words, it is regulatory.

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[1] Taken from *Behavior of the Lower Organisms*, pp. 338–39. New York: Columbia University Press. Copyrighted, 1906.

Behavior is merely a collective name for the most obvious and most easily studied of the processes of the organism, and it is clear that these processes are closely connected with, and are indeed outgrowths from, the more recondite internal processes. There is no reason for supposing them to follow laws different from those of the other life processes, or for holding that regulation in behavior is of a different character from that found elsewhere. But nowhere else is it possible to perceive so clearly how regulation occurs.

B[1]

BY C. JUDSON HERRICK

Individual modifications of behavior, of course, can occur only if there is a certain capital of innate action system or reflex pattern with which to work. These two factors are never dissociated in practice. The innate patterns of any particular kind of animals have also grown up during use in the course of phylogeny and are in a sense functional modifications of earlier patterns. These patterns, however, have developed very slowly through biological agencies like natural selection which are able to effect relatively permanent changes in the organization of the protoplasmic "physical basis of life" and so are heritable. The individual modifications, on the other hand, are relatively quickly acquired and, while enduring for a time, do not involve any so permanent changes in the organization. They are in general not hereditary.

The term "modifiability" is used here in a very comprehensive sense. In all behavior we must distinguish: (1) the change in the environment of the reacting protoplasm, termed the stimulus, which causes the excitation; (2) the internal changes within the protoplasm itself which comprise the excitation and reaction. If internal changes persist after the completion of the reaction in such form as to alter the character of succeeding reactions, the protoplasm may be said to have been modified and these subsequent reactions which show the effects of this change may be classed as modifiable behavior.

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[1] Adapted from *Neurological Foundations of Animal Behavior*, pp. 283–87. New York: Henry Holt & Co., 1924.

Modifiability in this wide sense includes fatigue, acclimation, associative memory, and many other effects of past experience, in short, all of the internal factors of behavior except those immediately consequent upon the stimulus. Some modifications are evanescent, while others may persist throughout the life of the individual. This persistence of internal change is a true mnemonic function, ranging all the way from a transitory facilitation by use, through the so-called physiological memories of lower animals slowly acquired by numberless repetitions, to the lifelong memories of single events so characteristic of human experience. Facilitation by use and acclimation are very elementary forms of this series of modifiable behavior.

In view of the similarity of the fundamental physiological nature of stable and modifiable behavior types, it is not surprising that in the lowest organisms these types tend to merge and lose their distinctive features. But in the more highly specialized animals the contrast between them becomes more and more significant. The origin and mechanism of the evolutionary and developmental modifications which have grown up slowly through the action of natural selection and similar biological factors need not concern us in this connection. We accept these as given and our present interest in them is merely to learn what they are in the species or race under consideration. This is important, for they furnish the individual with a certain capital of inherited action system or reflex pattern with which to work. His success in life will depend upon (1) the perfection of the adjustment or adaptation of the stable innate action system to the actual environing conditions in which he lives, and (2) the capactity of the organism to vary these native impulsions in adjustment to new situations not provided for in the inherited action systems, that is individual modifiability of behavior.

This modifiability arises ordinarily from maladjustment. As long as the machinery of living is running smoothly and the innate organization of reflex and instinctive patterns is adequate to maintain the life and comfort of the body there is nothing to disturb the course of these reactions. But when external or internal conditions arise for which no apparatus of adjustment is already provided new combinations of the possible reflex elements may be made.

Nature, though prodigal in some of her moods, is very parsimonious in others; and in accordance with the law of parsimony general modes of behavior common to all members of a species, produced on a wholesale scale from the same pattern, are employed in all cases in where they suffice. In lower forms with unlimited powers of rapid multiplication it appears to be more economical to standardize modes of behavior and limit these to a few rigidly determined types and to sacrifice the individuals who find themselves so situated that these circumscribed action systems break down.

Even the lowly organism does not yield to this fate without a struggle. Endowed with a certain capacity for general motility not specifically excited by an external stimulus, in an emergency for which no stereotyped response is directly provided in the innate action system it rapidly tries in turn all forms of response permitted by its organization, and if the outcome is successful the organization may be so altered as to facilitate a similar adjustment on repetition of the situation. The animal, we may say, has learned (physiologically) or has acquired a physiological habit which may persist for a longer or shorter time.

This kind of individually acquired modifiability is apparently biologically more expensive than the execution of reactions already standardized and provided with appropriate ready-made structural devices. It is very feebly developed in protozoans, and as we pass to higher forms the stabilized and the labile or modifiable types of behavior become more sharply differentiated, appearing on one hand as tropisms, reflexes and instincts and on the other hand as acclimation, habit, docility, intelligence.

The more labile behavior is higher as measured by the biological standard or more effective control of environmental forces. All that gives man his dominant position in the world is his pre-eminent capacity for modifying his conduct to suit the varying exigencies of life. Human education has as its prime purpose to supplement and often to supplant the inborn "natural" impulses of childhood by more appropriate intelligently acquired modes of action. This is in fact the characteristic human type of regulation of behavior.

The more highly complex forms of individual modifiability are termed associative memory and intelligence, and the latter is by definition consciously performed. Whether consciousness is present in the simpler forms of associative memory as these are demonstrated by students of animal behavior in lower animals, cannot be positively determined. In the behavior of lower animals there are no criteria which enable us to tell with certainty whether a given act is consciously performed or not, and therefore the lower limits of intelligence in the animal kingdom are problematical. But quite apart from the question of consciousness, the manifestations of modifiable behavior form a graded series from the simplest biologically regulated phenomena of the Protozoa to the highest human activities, so far as these are objectively manifested.

These two kinds of behavior are independent variables; both are always present in some measure, but in different proportions in the several species. Broadly speaking, in lower organisms the stable kinds predominate and the more labile assume greater importance in higher species, until in mankind individual modifiability takes the form of intelligent adjustment, learning by experience, and all the varied resources of physical and mental education with the powerful aid of accumulated traditional and documentary culture.

The second, or modifiable, form of behavior is sometimes called indeterminate in contrast with the more rigidly determinate or stereotyped reflexes, instincts, etc., of the first type; but, of course, this does not imply that the modifiable behavior is indeterminate in the sense of uncaused. The causes of reflex and instinct are acting uniformly on many individuals through long periods of time and the acts of all the members of a given species in a particular situation can be predicted with considerable precision so far as they are of this type. The causes of modifiable behavior, on the other hand, vary from moment to moment so that each act must be separately considered and no general formulation is possible. Moreover, most of these causes are obscure changes in internal physiological processes not readily open to observation or mental processes still more difficult of correlation with the physiological sequences.

Stereotyped behavior implies sameness in all members of a species, innate similarities, as an outstanding feature. Modifiable behavior implies personally acquired differences. However much of uniformity there may be in all members of a race, there is superposed upon this an individuality which is personal and qualitatively different. The individual is not merely *other* than others in external (time and space) relations; he is different from the others in intrinsic nature, that is, in pattern of organization. This is the basis of human personality, which is the natural flower and fruitage of the elaboration of modifiable behavior, as Ritter (1921) has pointed out.

Besides the innate stable factors of behavior typified by tropism, reflex and instinct, there is also a personal acquisition of stabilized behavior, a tendency for acquired behavior, if often repeated, to become ingrained as habit and so-called acquired automatisms. The failure to distinguish clearly between these two types of fixed or stable behavior has been responsible for a world of fruitless polemics in the domain of instinct. The first type is innate; the second is acquired, and if originally learned through conscious effort is a true "lapsed intelligence."

The lapsed intelligence is as adaptive as the reflex or the inherited instinctive action, but the conscious factor originally present may be wholly or partially lost. This kind of behavior has often been invoked to account for the origin of instincts of lower animals, but the indications are that most instinctive acts have a quite different origin. On the other hand, the lapsed intelligence type plays a major part in human behavior, for much of education and training is nothing other than the fixation of reaction types at first learned by close attention and conscious control at every step, so that ultimately they go off of themselves by "second nature," as we correctly say.

EXERCISE

1. Consider the daily lives of a man and a dog. In which case is regulation more frequent? Why?

2. THE MAKE-UP OF HABITS[1]

BY JOHN BROADUS WATSON

Content of the term habit.—It has been shown that instinct is analyzable into simple congenital reflexes. It has been suggested that habit also might, so far as analysis goes, be found to consist of congenital reflexes. Experimental studies upon habit formation lend support to this view. Instinct and habit differ so far as concerns the origin of the *pattern* (number and localization of simple reflex arcs involved) and the *order* (temporal relations) of the unfolding of the elements composing that pattern. In instinct both pattern and order are inherited: in habit both are acquired. We do not hesitate to define habit as we do instinct—as a complex system of reflexes which function in a serial order when the organism is confronted by certain stimuli, provided we add the clause which marks off habit from instinct, viz., that in habit the order and pattern are acquired during the life of the individual animal. After habits are perfected they function in all particulars as do instincts. No mere examination of adult animals will enable us to differentiate between the respective rôles of habit and instinct, since the one observable difference between the two types of acts is that of origin. Since habits are thus seen to be individual acquisitions of particular animals, it is necessary to describe the process by means of which certain reflexes are selected out from among a very large number of possible reflexes. It may be inferred from the above statements that the organism is dependent upon heredity for unit acts. The number of these apparently can never be increased or decreased, but large numbers of them can be shaped so as to form different types of habit, depending upon the kind of environment into which the organism is thrown. The organism is so constructed that when certain stimuli are presented certain types of random movements are set free. Individuals certainly differ enormously in the number and kinds of random activity which they may display upon the presentation of given stimuli.[1] If appropriate random acts do not appear upon the incidence of the given stimulus, it is fruitless to attempt to establish habits respecting that stimulus, e.g., if the child fails to respond adequately to colors, pencils, chalk, and to the form and size of objects (when intensity and combination are sufficiently varied) it is useless to try to instil artistic habits. On the other hand, this same child may show a rich display of random activity, suitable to the formation of habit, when presented with the objects belonging to what are called the mechanical arts or trades; habits under such conditions are formed quickly and readily. It seems safe to conclude that all of the vocations are probably at bottom dependent upon particular hereditary types of organization, i.e., dependent upon the presence of random activity of proper kinds. The same thing appears in the case of the animals. It has long been recognized that in order to get the animal to form habits one must set problems for him which will call only for the random type of activity of which he is capable. One does not usually set the same type of problem for a bird that one sets for a monkey. We scrutinize pretty carefully in the young animal the repertoire of random activity, and so shape the problems that their solution calls for no unit acts not in his repertoire.

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[1] Adapted from *Behavior, an Introduction to Comparative Psychology*, pp. 184–87. New York: Henry Holt & Co., 1914.

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[1] It would be interesting to test habit formation under conditions such that instead of increasing the stimulating value of an object (complex stimuli) we should heighten the state of irritability of the organism by the administration of strychnine, etc. The effect of drugs on behavior can be more easily attacked in the animal than in the human world.

Restatement.—What we emphasize in brief may be stated again: when an animal is presented with a stimulus which calls forth random movements (e.g., food inside of a problem box), the reflex repertoire is set free. Now in this repertoire is a combination of reflexes which will enable the animal to get food. In some way this combination gets selected and in time comes to be the only system which responds when that particular object is presented to the animal.

EXERCISE

1. What factors determine the promptness with which an organism will solve a given problem, i.e., will form a new habit?

3. THE PROCESS OF ADJUSTMENT[1]

BY HARVEY A. CARR

The inability to adapt to a motivating situation constitutes a problem, and the acquisition of a new mode of response adapted to that situation is a process of learning. All learning involves mental activity,—the use of previous modes of activity in effecting a new adjustment. We shall attempt an analysis of the *primitive method* of learning in the realm of sensori-motor activity. For purposes of illustration we shall describe two cases of learning exhibited by animals.

A dog has been taught to retrieve a cane. His master throws the cane over a high picket fence. The distance between the pickets is sufficient to permit the dog to pass between them. On being commanded to bring the cane, the dog bounds through the fence, seizes the cane in the middle and attempts to return. The animal is now confronted with a problematical situation to which he is motivated to respond by his past habits of reacting to master and cane, and the gratification of this motive is dependent upon the discovery of a new mode of response adapted to the exigencies of this particular situation. The animal now tries out in a random and unsystematic order all of his past methods of dealing with a fence situation. He runs up and down the fence seeking a gate or a larger opening, he attempts now one panel and then another, he makes futile attempts to jump over, he attempts to crawl or dig, or at times he sits on his haunches and begs and whines,—a method which in times past has proved efficacious in escaping from difficulties. In these wild scrambles the dog is continually dropping the cane and seizing it again. He finally chances to seize the stick near one end and thus succeeds in carrying it through between the pickets. But this adaptive response is not yet learned. When the test is repeated on succeeding days, the same process of solution is duplicated with the exception that the time involved is gradually decreased with successive trials until the act is finally perfected. The dog will bound through the fence, immediately seize the cane at one end and return without unnecessary delay. The problem is now mastered: a new adaptive response has been learned.

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[1] Adapted from the manuscript of a textbook in psychology.

A hungry rat is confronted with food placed within a small wire cage. The floor about the cage is covered with saw dust. At one end of the cage is a small door which will swing open when a wooden lever latch is lifted from its catch. To enter the box the rat is compelled to learn the trick of lifting this latch with its nose. Motivated by hunger and the odor of food within the box, the animal tries out all of its previous modes of dealing with obstructions to food. It attempts to nose its way through the openings of the wire mesh, clambers all over the box in the search for a larger opening, digs at various places in the saw dust, and attempts to gnaw through the wires. While frantically working near the latch, a chance movement of the head happens to release it, and the rat gains access to the food. On succeeding trials the same process is repeated with the exception that the time of entrance is gradually shortened until finally the animal is able to open the door immediately without making any unnecessary movements.

In both cases there exists a *problematical situation* to which the animal is motivated to respond. The problem is solved by means of a *variable motor attack* which persists until the successful act is discovered by chance. Finally comes the process of *fixation and elimination* by repetition. The wrong acts are gradually eliminated and the successful act more thoroughly engrained in successive trials until the problem is mastered.

EXERCISE

1. What are the points of similarity and of difference between the problem-solving of human beings and that described of a dog?

4. SELECTIVE MODIFICATION

A[1]

BY WALTER S. HUNTER

At the time neural associations are formed why are certain ones excluded? In this connection Watson has made use of the phrase, "the fixation of arcs in habit," in referring to the essential factors that determine the fixing of acquired associations between reflex arcs. For convenience we shall phrase our statements positively and speak of factors making for fixation and retention, though we are at the same time pointing out the factors that make for elimination and forgetting.

Angell enumerates the following stages in the formation of a habit: (1) appearance of the stimulus, (2) random movements, (3) accidental success, and (4) elimination of all or most of the random movements. I see the typewriter before me. My hands make clumsy, awkward, slow movements. My body as a whole is strained and perhaps contorted. From time to time I make proper movements and succeed in my writing. Gradually my awkwardness vanishes, and I write accurately, at great speed, and with a minimum of effort. Let us take a laryngeal habit in order to illustrate the stages still further. (1) I see a list of French words and their English equivalents before me. (2) I repeat the list over and over with much bodily tension and with many random movements (mistakes) of the vocal organs. (3) From time to time I succeed in repeating portions of the list. (4) Errors are finally eliminated and the habit is complete.

Our fundamental question at present is with reference to the *elimination of random or unsuccessful movements*. Three investigators have presented views that require comment: Thorndike (1911), Carr (1914), and Watson (1914). The factors making for the fixation of associations, according to Thorndike, are frequency (the law of exercise) and satisfaction (the law of effect). Thorndike states these laws as follows:

> The Law of Effect is that: Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weak-

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[1] Adapted from *Human Behavior*, pp. 293–96. Chicago: University of Chicago Press, 1928.

ened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond.

The Law of Exercise is that: Any response to a situation will, other things being equal, be more strongly connected with the situation in proportion to the number of times it has been connected with that situation and to the average vigor and duration of the connections.[1]

According to Carr, the essential factors are frequency, recency, and intensity. Watson favors only frequency and recency. In our own judgment there is every reason to believe that frequency, recency, and the facilitating and inhibiting effects of avoiding reactions and visceral disturbances are the important factors. Upon frequency all are agreed. A succession of responses that is frequently repeated is thereby learned, unless some inhibiting factor is active. The neural connection, underlying a movement recently made, retains a low resistance and so tends to be traversed again. The genuine dispute comes over the manner of formulating Thorndike's law of effect. Even as Thorndike has stated it there is a suggestion of mastery, and psychologists in general have aggravated the situation by saying that pleasantness and unpleasantness are factors influencing learning. The observable fact seems to be that certain stimuli set up avoiding reactions, such as spitting things from the mouth and removing the finger from injurious objects, and that certain stimuli set up widespread visceral changes, such as the changes in the activity of the digestive tract when the organism is affected by nocuous stimuli. Any stimulus-response coordination which occurs in connection with such stimuli will have its chances for reinstatement lessened. Let us illustrate this with the case of a child who is given bitter medicine. The child is stimulated visually by the spoon and auditorily by the parent's voice. The response made to these stimuli is the taking of the medicine. The gustatory stimulation from the medicine causes the child to spit, gag, and withdraw its head. The next time the child is offered the medicine he responds by withdrawing the head and even by gagging and spitting. The response of taking the medicine has been eliminated. A similar situation occurs when an infrahuman animal is punished by having to retrace a blind alley in a maze or when it receives an electric shock in a discrimination box. The responses which immediately precede the behavior set up by the punishment are thereafter inhibited and eliminated.

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[1] E. L. Thorndike, *Animal Intelligence* (New York, 1911), p. 244.

B[1]

BY C. LLOYD MORGAN

With regard to the objects at which domestic chicks peck, in the absence of any parental guidance, one may say that they strike at first with perfect impartiality at *anything* of suitable size: grain, small stones, bread-crumbs, chopped-up wax matches, currants, bits of paper, buttons, beads, cigarette-ash and ends, their own toes and those of their companions, maggots, bits of thread, specks on the floor, their neighbours' eyes—anything and everything, not too large, that can or cannot be seized is pecked at, and, if possible, tested in the bill. There does not seem to be any congenital discrimination between nutritious and innutritious objects, or between those which are nice and those which are nasty. This is a matter of individual acquisition. They soon learn, however, what is good for eating, and what is unpleasant, and rapidly associate the appearance with the taste. A young chick two days old, for example, had learnt to pick out pieces of yolk from others of white of egg. I cut little bits of orange-peel of about the same size as the pieces of yolk, and one of these was soon seized, but at once relinquished, the chick shaking his head. Seizing another, he held it for a moment in the bill, but then dropped it and scratched at the base of its beak. That was enough; he could not again be induced to seize a piece of orange-peel. The obnoxious material was now removed, and pieces of yolk of egg substituted, but they were left untouched, being probably taken for orange-peel. Subsequently, he looked at the yolk with hesitation, but presently pecked doubtfully, not seizing, but merely touching. Then he pecked again, seized, and swallowed.

To some other chicks I threw cinnabar larvae, distasteful caterpillars, conspicuous by alternate rings of black and golden-yellow. They were seized at once, but dropped uninjured; the chicks wiped their bills—a sign of distaste—and seldom touched the caterpillars a second time. The cinnabar larvae were then removed, and thrown in again towards the close of the day. Some of the chicks tried them once, but they were soon left. The next day the young birds were given brown loopers and green cabbage-moth caterpillars. These were approached with some suspicion, but presently one chick ran off with a looper, and was followed by others, one of which stole and ate it. In a few minutes all the caterpillars were cleared off. Later in the day they were given some more of these edible caterpillars, which were eaten freely; and then some cinnabar larvae. One chick ran, but checked himself, and, without touching the caterpillar, wiped his bill—a memory of the nasty taste being apparently suggested by association at sight of the yellow-and-black caterpillar. Another seized one, and dropped it at once. A third subsequently approached a cinnabar as it crawled along, gave the danger note, and ran off. Then I threw in more edible caterpillars, which again were eaten freely. The chicks had thus learnt to discriminate by sight between the nice and the nasty caterpillars.

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[1] Adapted from *Habit and Instinct*, pp. 40–42. London: Edward Arnold, 1896.

C[1]

BY L. T. HOBHOUSE

The inference from Mr. Lloyd Morgan's observations seems clear enough. The inherited tendency of the chicks is to peck—to peck at "anything and everything, not too large." But experience very rapidly teaches that it is pleasant to peck at some things—such as yolk of egg or cabbage-moth caterpillars—and very unpleasant to peck at others, such as cinnabar caterpillars or bits of orange-peel. The tendency to peck at the one sort of object is accordingly confirmed. The tendency to peck at others is inhibited. And the result is that pecking, from being an indiscriminate tendency, becomes a definite mode of response to certain objects. The instinctive tendency is regulated, narrowed, and defined, as it becomes a habit in which experience has played its part.

This form of the action of experience is very widely diffused in the animal kingdom, and is too simple to need much further illustration. But I may note one or two cases illustrating an important difference in one point. One instance was sometimes enough to teach the sharp little chicks. But the effect of the experience tends to wear off with time. The chick that had learnt to reject the cinnabar larva at one hour would perhaps try it again later in the day, or perhaps he would make a movement to try it, and then, as we should say of a human being, recollect himself. More marked cases of this gradual growth and equally gradual obliteration of the effects of experience may be seen in other animals. Thus Dahl gave a spider a fly dipped in turpentine. The spider sprang upon it three times, and, disliking the turpentine, withdrew on each occasion. After the third attempt it turned aside when the fly came in sight. Three instances sufficed to inhibit the impulse to spring. Nor would the spider for some hours attack a fly of the same species that was innocent of turpentine. The next day the spider attacked the fly in turpentine again, but once only.

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[1] Adapted by permission from *Mind in Evolution*, pp 116–21. London: Macmillan & Co. Copyrighted, 1915.

Here three experiences were necessary to establish the result in the first instance, and on the following day the effect was partially obliterated, so that one instance was needed to renew it. Every one is familiar with similar points in the working of human memory—the "fixing" of a verse by repetition, its fading with time, and its revival by perhaps a single reading.

It may be worth while to place in contrast with the instances given above a case of extreme stupidity in this respect. Speaking of a number of fish in an aquarium, Mr. Bateson says:

"None of the fish seem to get any lasting appreciation of the nature of the plate glass wall of the tank. The same fish will again and again knock its head against the glass in trying to seize objects moving on the other side."

A dangling button, or even a curl of smoke, may attract them. After repeated attempts they will desist, but some of the oldest inhabitants, which have been living in the aquarium about a year, will try again next time. This failure is no doubt partly due to dullness of sense perception, but, considering the length of time allowed for learning, it implies a surprising incapacity for turning experiences to account—a stupidity surpassing even that of Möbius's pike, which, after dashing itself for three months against a glass partition in the attempt to get at some minnows, became at last so firmly persuaded of the danger of attacking them that, when the partition was removed, it left them quite unmolested.

The cases which have been quoted, and which might be indefinitely multiplied, admit of a simple general description. A certain stimulus, in the case of the chick some small object within striking distance, evokes a reaction—in this case pecking. This reaction has a certain result, connected in this case with the swallowing or tasting of the object, and in future the same stimulus evokes a modified reaction. The modification may be in either of two directions. The "result"—the tasting or swallowing—may be to *confirm* the original mode of reaction, so that in one instance that sort of object is in future preferred for pecking at and swallowing to others. This was the case with the yolk of egg and the green caterpillars. Or it may be to prevent or *inhibit* the reaction, as in the case of the orange-peel or the cinnabar larvae. In either case, we have a sequence of facts which we may symbolise thus:—

	Stimulus	Reaction	Consequence
	s	r	p
followed by			
	s	ρ	π

In this sequence, all the links mentioned but one are matters of direct observation. That one is the consequence which I have called p. Now, in our human experience, we have also direct knowledge of p. It is in such simple cases as those described a feeling, and if its action is *confirmatory* of the reaction which caused it, it is a pleasant feeling; if *inhibitory*, a painful feeling. We need not labour this point. The burnt child dreads the fire because it hurts, and continues to steal the sugar with increasing avidity because it is sweet. In the case of the chick we cannot directly observe the feeling. We can, however, be sure that something happens in the place where we have put p, otherwise there would be no cause to account for the subsequent change—and the action of this something is precisely analogous to the action of pleasure and pain in human experience.[1]

[1] We feel sure about the child, first, because we know our own feelings, and it is so like ourselves; and secondly, because it expresses itself in ways which we understand. The chick is not quite so like ourselves, and we do not understand all its expressions so readily. Still, the inference is at bottom the same.

Here and elsewhere I use the term "feeling" as the generic expression for every state in so far as it interests the agent. Of such interest two things seem universally true. It is not a detached, so to say self-subsistent, state, but adheres to or inheres in some object, or if the term be preferred, some content. Thus in sensory feeling it is an object of sense which is felt as pleasant or painful. In some experiences, *e.g.*, in internal pain, it is true that the feeling is itself the predominant factor, but even here there is some more or less definite recognisable quality, *e.g.*, a diffused ache or pressure, or a sharp sting which so to say is the subject carrying the pain as predicate, and we approach rather than reach the limit of pure feeling without sensory content. Secondly, feeling is the basis of conation but not the same thing as conation. In the simplest forms the two tend to identity—simple sensory pain, *e.g.*, involving either flinching or efforts of rejection as part of itself, but the feeling as such is not the act as such. It is its immediate basis. Pain, moreover, as I use the term, is always (in the absence of inhibition) the basis of a negative conation. Apparent exceptions arise from the fact that intensity is an essential element in feeling, whence it comes about that some sensations, *e.g.*, those of a prick or a slap, while normally painful may be indifferent or even in certain states of organic tension pleasurable in low degrees of intensity. In these cases the sensory experience has acquired the name of a "pain," and so we hear of pains in which there may be a certain pleasure.

The analogy may be carried a little further. Confining ourselves for the moment to the action of pain and the case in which a mode of reaction is inhibited, we have to remark that the act of inhibition is of a twofold character. We have spoken already of the subsequent and more or less permanent effect of the painful experience, but this is only a sort of repetition of its immediate effect. If there is time, pain inhibits or arrests the particular action that is causing it. A nasty morsel is spat out from the mouth; the hot potato is dropped before it is well seized. It is the same with the chicks. The orange-peel, the very first time it is seized, is "at once relinquished, the chick shaking his head." Another is held for a moment, and then dropped, the chick scratching "at the base of his beak"—to rub away the taste, as a child would explain. Significant in this relation is the behaviour of another chick, which had already had experience of cinnabar larvae. When, later in the day, more were given him, he "ran but checked himself, and without touching the caterpillar, wiped his bill." Mr. Lloyd Morgan explains this as due to "a memory of the nasty taste" being "suggested by association at sight of the yellow and black caterpillar." We may be content to point out that a movement of rejection, a movement adapted to getting rid of a nasty taste, is evoked by the sight of the caterpillar just as it was in the original experience by its presence in the chick's mouth. In the same way, to swallow very disagreeable food may produce in us retching or actual sickness, and if the impression is very strong, the mere sight or even the bare idea of such food may subsequently produce a certain feeling of nausea, or perhaps evoke gestures expressing violent rejection.

The upshot of these considerations is that the pain felt in such cases,[1] is the expression in consciousness[2] of inhibitory movement—withdrawal, shrinking, flight, rejection, whatever it may be that is best adapted to cutting short the effect of some stimulus, or some reaction which one has incautiously made. Conversely, pleasure is the expression of confirmatory movement tending to prolong the reaction, or carry it out strenuously to its final development—to swallow with gusto, or to expose more and more of the surface to the pleasing contact.

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[1] I am far from saying that there is no other source of feeling than the motor reaction to sense stimulus.

[2] The term "expression" is meant to convey a concomitance of the intimate nature of which we are ignorant, though we know it must be something other than bare concomitance.

From this slight account, we can gather a certain conception, however inadequate, of the nature of the change whereby experience modifies a reaction. The first point which emerges clearly is that the inhibitory movement, which on a superficial view may seem to appear for the first time after the organism has once had a "painful" experience, really first appears in the first experience itself, and is merely repeated under somewhat modified conditions, and accordingly with different results, in the later experiences. Let us analyse this modified repetition. The sight of the cinnabar caterpillar was at first a stimulus to pecking. The result of the peck was the *taste*, and the taste involved the movement of rejection. But the taste also of course involved contact of the food with the tongue or palate, and if we divide these two stages of the consequence p of the reaction, we get altogether not three stages, but four.

s—	r—	c—	ρ
(the sight)	(pecking)	("unpleasant" taste)	(movement of rejection).

Afterwards we have s followed at once by

	ρ
(the sight)	(rejection).

Strictly, what is altered is not ρ, which came into existence, at any rate, in tendency and effect, in the first experience, but the effect of s. s, which before called forth r, now excites ρ, and the intervening stage c seems to have nothing to do with the matter. How then is the action of s modified?

We can partly answer this by understanding accurately how far it has been modified. In this way: that instead of evoking as before a pecking movement, it either has no outward result at all, or it evokes a contrary movement of rejection or aversion, which movement is of the same character as one that it previously excited through an intermediary. This gives us the broad character of the whole proceeding. The excitement aroused by a certain stimulus has taken to itself or *assimilated* the character of another excitement which it has previously brought about. The excitement originally produced by the sight of the orange-peel prompted pecking. Pecking produced a contact with the inside of the bill, which in its turn produced a violent movement of rejection. Now the first excitement becomes clothed with the character of the second in greater or less degree, so that either the two motor excitements—the original and the acquired—cancel each other and produce absolute indifference, or the acquired effect predominates, and there is a movement of disgust.

EXERCISE

1. A child avoids putting its hand in the flame of a candle. Is it necessary to assume that every time he refrains from this act he consciously remembers having been burned by a candle flame? Justify your statement.

5. THE RATE AND LIMIT OF LEARNING

A.[1] The Curve of Learning

BY DANIEL STARCH

The rate and progress of learning may be expressed in terms of the amount done per unit of time, or in terms of time required per unit of work. The relation between these two variables is represented by the curve of learning in which one function, usually time, is repre-

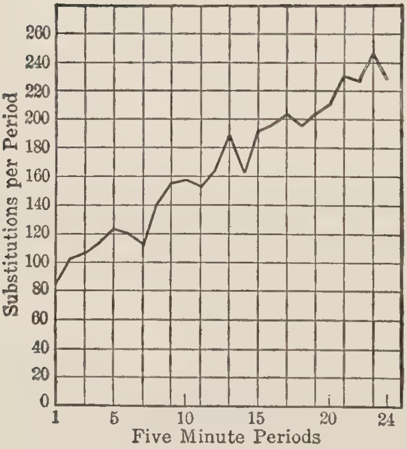

FIG. 27.—A curve of learning showing the progress of one person in learning to substitute numbers for letters. (Starch, *Experiments in Educational Psychology*.)

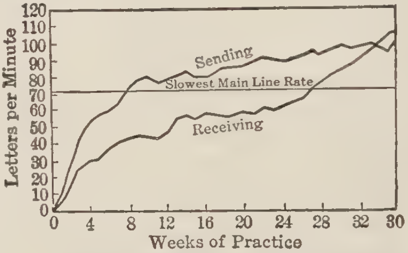

FIG. 28.—Improvement in telegraphy. Individual, E. L. B. After Bryan and Harter.

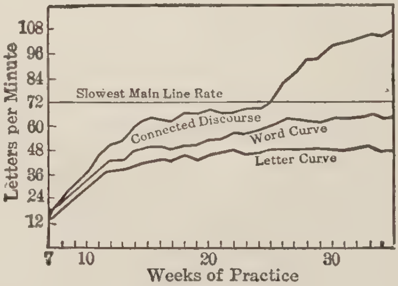

FIG. 29.—Improvement in telegraphy analyzed. Individual, J. S. After Bryan and Harter.

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[1] Adapted by permission from *Educational Psychology*, pp. 141–43. New York: Macmillan Co. Copyrighted, 1920.

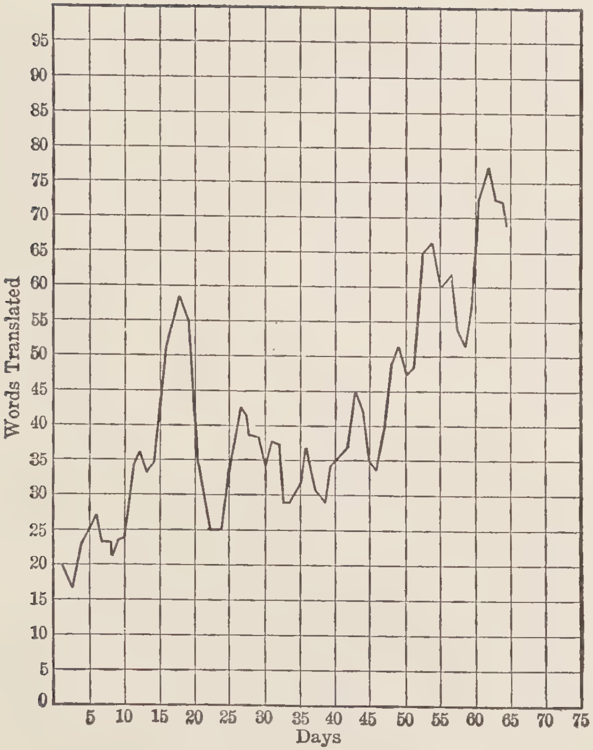

FIG. 30.—Progress in learning Russian. After Swift

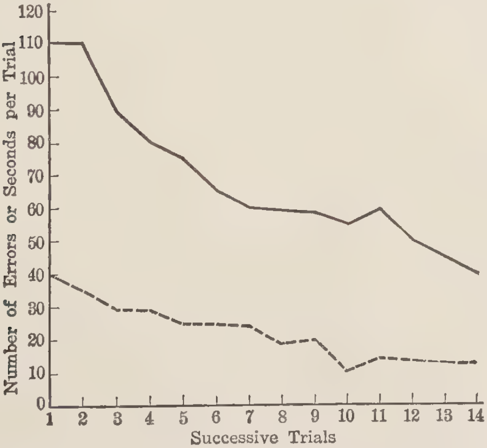

FIG. 31.—Improvement in tracing a star outline when seen in a mirror. Continuous lines represent reduction in seconds in successive trials. Dotted line represents reduction in errors.

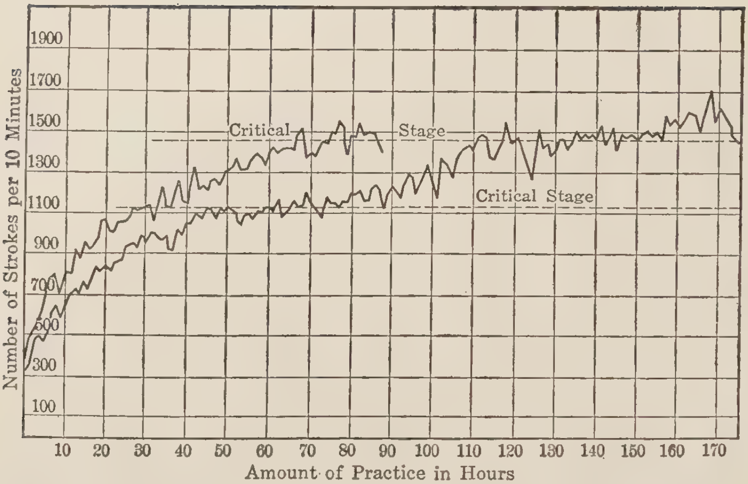

FIG. 32.—Improvement in typewriting by the sight method. After Book

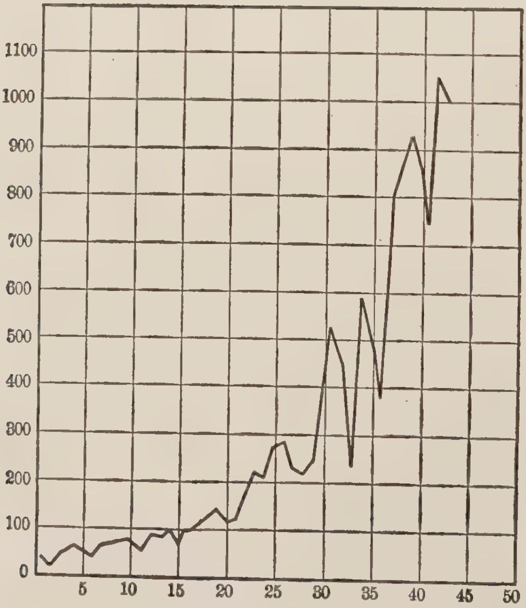

FIG. 33.—Progress in ball-tossing. The horizontal axis represents days The vertical axis represents the number of balls caught. After Swift.

sented along the base line, and the other, usually amount accomplished is represented along the vertical axis. Figure 27 represents a typical curve of learning in which progress is measured by the amount achieved per five minutes of time.

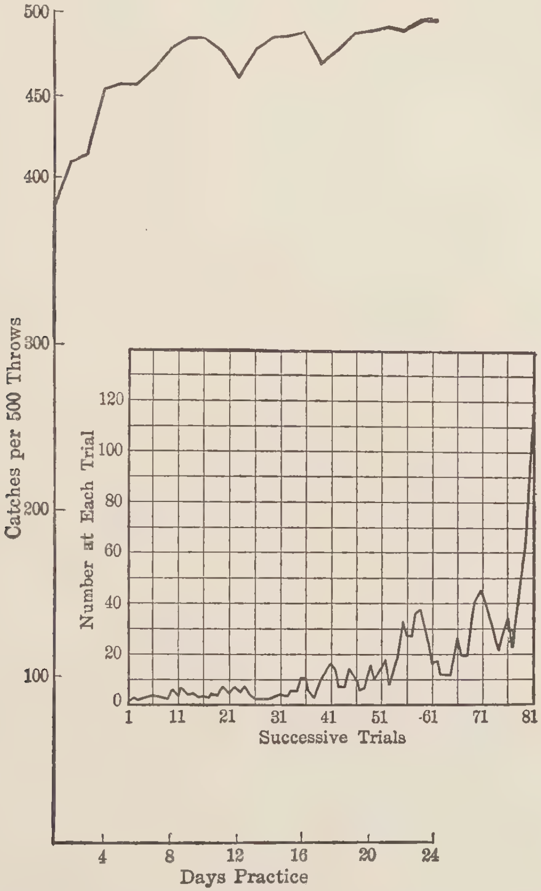

FIG. 34.—Lower graph shows Batson's original curve. Upper graph shows the reconstruction of his curve.

Characteristics of Learning Curves.—Most of the experimental work on the course of learning curves has been done chiefly with various kinds of skills such as telegraphy, typewriting, tossing balls, mirror tracing, substitutions, and the like. Little has been done on the progress of analytical types of learning, on the advance in the acquisition of facts of a science or of the history of a country, or on the rate at which a child learns to read or to write. Consequently most of our generalizations up to the present time have been based upon curves that represent the acquisition of skill. Such curves seem to have in common two general characteristics, although it is doubtful whether they are universal in all types of learning: (1) An initial period of rapid progress, and (2) successive periods of no progress, or plateaus, followed by periods of rapid progress. Theoretically, a curve of learning may have two initial directions: (1) rapid progress followed by slower progress, or (2) slow progress followed by more rapid progress, that is, a convex or a concave form with all possible shapes between these extremes. The large majority of curves of learning derived to date are of the former sort. All the illustrations reproduced in Figures 28 to 32 have this general shape. In the substitution test referred to in Figure 27 the author found that among twenty curves obtained from as many individuals, thirteen were of convex form, six were practically straight lines rising from left to right, and one was of concave form. Hence, initial rapid gain seems to be a very common feature in curves of skill. Other types of curves are shown in Figures 33 to 35.

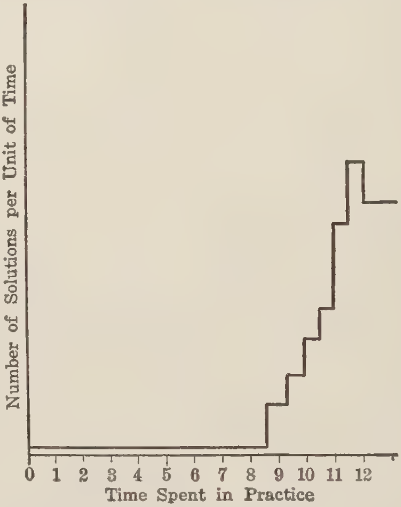

FIG. 35.—Curve to show the progress in solving puzzles. After Ruger as reconstructed by Thorndike.

The early period of rapid progress may be due (1) to the fact that the first elements of a new set of materials or a new set of associations may be picked up rather easily and quickly because of their simplicity, (2) to the probability that the first stage of practice in a new type of learning makes available various elements or activities already in the possession of the learner, (3) to the initial zeal in beginning a new task, (4) to the large opportunity for progress in the beginning, (5) to the physiological limit in many types of skill such as typewriting, mirror tracing and writing numbers for letters, and (6) to an absolute limit of the number of bonds that the task presents to the learner. Thus typewriting has a *physiological* limit in the rapidity with which the fingers can be moved in striking the keys. Progress cannot go on indefinitely at the original rate. Typewriting also has an *absolute* limit in the number of strokes to be learned.

EXERCISES

1. Examine the curve of Figure 27 which represents the rate of forming associations between numbers and letters. What can be said about the rate indicated in this curve?
2. Examine Figure 28. State the difference between the rate of learning to send and learning to receive.
3. In the curve of Figure 29 what is indicated as to the rates of learning for the different types of material learned?
4. If the curve of Figure 30 may be taken as characteristic of the rate of learning a language, what can you say about this rate?
5. In the curve of Figure 31 what is the relation between the decrease in time in the successive trials and the decrease in the number of errors in the same trials?
6. In Figure 33 the curve represents progress in learning to toss balls. How does this type of progress compare with the type of improvement in learning telegraphy?
7. What is especially striking in the rate of learning to solve puzzles as indicated in Figure 35? Can you suggest any explanation of this?

B.[1] The Limit of Learning

BY EDWARD L. THORNDIKE

The limit of efficiency of a mental function is, of course, rarely reached in experimental studies, save in the case of extremely "narrow" functions, such as knowing the meaning of one or a few words, being able to repeat a poem, or typewriting a single sentence. The best illustrations of mental functions at their limit of efficiency are to be found among those occupations of work or play excellence in which is sought with great zeal and intelligence. The championship "records" in typewriting, shorthand, telegraphic sending, golf, billiards, and the like, show approximations to the limits of improvement in the functions concerned in the case of individuals gifted by nature probably with specially high limits in the cases in question.

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[1] Taken from *Educational Psychology Briefer Course*, pp. 198–201. New York: Teachers College, Columbia University, 1915.

The feats of such experts—who can typewrite 60 words containing approximately 350 letters per minute, take down the most rapid speech without an error, send 49 words or 486 separate impacts on the telegraph key in a minute, keep four balls tossing in the air with one hand, multiply any number less than 1,000 by any similar number in a few seconds, drive a golf ball over two hundred yards within an angle of ten degrees, and the like,—are doubtless beyond what the majority of men could ever achieve. Such expertness is the product of a rare native ability as well as of long, intelligent and earnest practice. On the other hand, the efficiency possible in any one such function in the case of an ordinary person, who gives enough time and interest to well-advised practice in it, is, I am convinced, often underestimated. The main reason why we write slowly and illegibly, add slowly and with frequent errors, delay our answers to simple questions and our easy decisions between courses of action, make few and uneven stitches, forget people's names and our own engagements, lose our tempers, and the like, is not that we are doing the best that we are capable of in that particular. It is that we have too many other improvements to make, or do not know how to direct our practice, or do not really care enough about improving, or some mixture of these three conditions.

It is my impression that the majority of men remain far below their limit of efficiency even when it is decidedly in their interest to approach it, and when they think they are doing the best that they are capable of. I venture to prophesy that the thousand bookkeepers in, say, the grocery stores of New York who have each had a thousand hours of practice at addition, are still, on the average, adding less than two-thirds as rapidly as they could, and making twice as many errors as they would at their limit. It appears likely that the majority of teachers make no gain in efficiency after their third year of service, but I am confident that the majority of such teachers could teach very much better than they do. Even in a game where excellence is zealously sought, the assertion that "I stay at just the same level, no matter how much I practice" probably does not often mean that the individual in question has really reached the physiological limit set for him in that function.

I cannot prove the assertions made in the last two paragraphs, since the experiment of subjecting such individuals to practice under proper conditions of methods and interest has not been made. Nor can I give the evidence that has led to the assertions, since it includes too many fragmentary facts from too wide a variety of sources. Only a few examples of the facts that seem to me to show that men in general thus fall short of their possible efficiencies can be quoted.

First, hardly any functions have ever been practiced in the course of the scientific study of mental functions which did not improve and, provided they were of fairly narrow scope and with success and failure easily distinguishable, at a fairly rapid rate.

Second, there are striking cases of individuals who have had enormously long practice, as taken in the course of schools or trades, and who have kept at the same level of efficiency for a long time, but who, under more favorable conditions, make notable advances. For example, Aschaffenburg had four experienced type-setters set type for an hour and a quarter, on each of four successive days, in their own shop, with their own type, etc. Either they held back in the early days for no intelligible reason, or they improved notably under the stimulus of an observer and the zeal to make a good showing.

The first and third were "normal" days; on the second and fourth alcohol was administered, but not till after the first quarter-hour. The achievement, in terms of letters and spaces "set" in the first quarter hour of each day, was as follows:

Day	Individual				
	F. S.	K. O. C.	C. H.	J. L.	Average
1	577	524	599	600	575
2	649	506	601	614	593
3	601	598	669	664	633
4	725	594	656	723	675

Third, a new stimulus to interest and effort, or a new method of training, often produces a similar advance in the ordinary work of the world. For example, the record in the pole-vault has risen in a score or so of years by many inches. This can only be explained by supposing that the pole-vaulters of twenty years ago could have vaulted much higher than they did, had they used better methods, or more zeal or both. Probably the jugglers of the past thought that keeping three balls tossing and balancing a chair on one's nose were the limits to skill until some one did keep four balls tossing or balance a chair on an umbrella on his nose. They then found that they too could do likewise.

It seems to me therefore that mental training in schools, in industry and in morals is characterized, over and over and over again, by *spurious limits*—by levels or plateaus or efficiency which could be surpassed. The person who remains on such a level may have more important things to do than to rise above it; the rise, in and of itself, may not be worth the time required; the person's nature may be such that he truly cannot improve further, because he cannot care enough about the improvement or cannot understand the methods necessary. But sheer absolute restraint—because the mechanism for the function itself is working as well as it possibly can work—is rare.

EXERCISE

1. Recite the alphabet backward twenty times. Time yourself on each successive trial. Plot your results in the form of a learning curve. Explain the form of this curve.

6. LEARNING TYPEWRITING[1]

BY WILLIAM FREDERICK BOOK

In learning typewriting two groups of special habits are formed. (1) Habits or manipulation, or the specific psychophysical associations involved in the mastery of the writing itself. (2) Habits of control, certain more general or more purely mental habits formed in conjunction with the habits of manipulation—habits that are not involved in the writing directly, but rather preside over the formation of the special typewriting habits. In other words in learning to typewrite the learners acquire in addition to the habits of manipulation (the typewriting habits which enable them to deal more and more directly and economically with the particular problems presented by the writing), certain other habits which enable them to deal more and more successfully with the problems involved in the learning itself. Specifically the subjects learn: (*a*) How to "short circuit," or acquire to advantage the kind of habits which the mastery of the subject requires; (*b*) How to meet and successfully overcome the many special difficulties which are characteristic of the learning of typewriting; (*c*) How to acquire and maintain a helpful attitude of feeling; (*d*) How to keep attention focused always on the writing; (*e*) How to use attention more and more effectively when applied to the writing. How better to use and economize voluntary effort, etc.

The habits of manipulation, involved in the mastery of typewriting, are of all kinds and degrees, ranging from the most simple and elementary associations used by the beginner to the complex hierarchies of co-ordinated habits used by the expert. In beginning to write by the "touch" method, for example, an association must first be formed between the sight of each letter in the copy, or its mental equivalent (some form of inner spelling), and the thought of the exact position of the corresponding key, so that the sight or thought of the letter will call up instantly the exact position of the key. But this is only a necessary preliminary step in the process of getting the right finger to the key to be struck. This mental location of the key must promptly give rise to certain psychic processes and movements required to get the right finger to the key desired. This step, locating the key with the fingers, represents in the beginning a very difficult and roundabout process which must be gone through with for each letter before the final letter-making movement of the finger can be made. In the earliest writing each letter of the copy must be first fixated with the eyes (or spelled), its corresponding key separately located, first with attention, then with the fingers, the letter again actually or incipiently pronounced before or as the key is being struck. As practice continues a "short circuiting" in each part of this five-step process reduces all to one in consciousness. The sight of the letter in the copy, or its mental representative, the spelling, comes to call up at once the one proper letter-making movement, which by careful attention to its details can be properly guided or directed as made. When this has been accomplished a "letter association" has been formed. With continued practice these letter-making movements become easier and easier until little conscious direction is needed for their proper performance. The separate movements for a group of letters representing a frequently recurring syllable or word follow a course of "short circuiting" similar to that which eliminated the separate steps early required in making a letter. The letter-making movements begin to need less and less individual guidance and finally drop out of consciousness sufficiently to permit the syllable and word to be reacted to as a whole. In other words a direct association is formed between the sight or inner pronunciation of the oft recurring syllables and words and the total groups of movements required for writing them. The word has now become the unit for attention and is reacted to as formerly were the letters or still earlier the individual steps in the process of making letters, at first in a very detailed way, then more and more generally as the higher-order (word) associations are perfected and phrase associations are formed. As skill increases certain groups of movements representing the syllables and words begin to link themselves together for certain phrases and clauses, attention dealing with the larger group of movements involved in writing as before, first in detail then in a more and more unitary fashion, until the larger group is no more of a task for consciousness than was once the letter and word. A direct association is thus formed for the easy and more familiar phrases.

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[1] Adapted from *The Psychology of Skill*, pp. 168–72. Missoula: University of Montana Publications (1908), Volume I. Also to be found in *The Psychology of Skill*. New York: Gregg Publishing Co., 1925.

The following facts were obtained concerning the growth and development of these special habits:

1. The special typewriting associations or habits of manipulation are all developed and perfected in a definite manner. The earliest associations employed in the writing are formed from the masses of familiar associations and activities which the learner brings with him to the work. In the beginning the learner's attention and effort cannot be applied to the writing in a direct and economical way. Under the influence of the strong desire to succeed in the new task there are called up masses of old and easy associations and forms of activity, most of which are not directly serviceable for the writing. From these associations and activities is built up by the double process of elimination and selection the first elementary, step-by-step, blundering associations used. By a further process of elimination and a simultaneous one of recombination, called into action by the extreme exertions of the learners in their eager desire to reach a higher speed and greater facility, their first elaborate and circuitous methods of writing are simplified, refined, changed, until, sheared of some of their accessories, they enter into and form the easiest and most direct method of work yet attained. Throughout the learning there is, if one may so phrase it, a sort of unconscious struggle for existence among many modes of action and methods of work, ending in the survival of the one most direct and economic way of reaching the goal. Some of the early habits called forth by the learning exist but to be eliminated, others enter into and constitute the first simple and direct habits used in the writing. These elementary habits are in turn modified and reorganized, as practice continues, as parts of higher and more economical groupings, in which their identity is gradually merged, while these higher groupings in turn are worked over into yet higher complexes by essentially similar processes.

Three facts of major importance were determined in regard to this process of short circuiting:

a) The new adaptations or forward steps in the learning were made quite *unintentionally* so far as the subjects were concerned. They were simply fallen into when the conditions were favorable for making a forward step and were executed marginally for some time before the learners became aware of their presence and value for the work. When the advantage of the new method had been noticed it was generally, thereafter, made use of purposely, though even then consciousness seemed to be more of a hindrance than a direct help. As Z expressed it: "I find that I have to let the thing do itself. When a new way of doing the work is noticed and I purposely try to use it or to assist, it never goes right."

b) The necessary pre-condition for taking a forward step in the learning was extreme effort, carefully applied to the work on a good day, when the older associations had been carefully revived and when the learners were thoroughly "warmed up."

c) The process of progressive organization and co-ordination of the simpler activities into higher and more economic and direct methods of writing becomes itself more and more difficult as skill increases. In the advanced stages of learning where the elements are more complex, new adaptations become harder to make, first, because the learners have had little or no experience in making higher groupings (as most learners are masters of nothing); second, because, for the lack of success or slower progress, attention naturally tends to drift away from the work, both in its details and as a whole, making the writing in the later stages of learning harder and harder to attend to.

2. It was determined in the second place that the special habits of manipulation involved in learning typewriting naturally and normally grow and develop simultaneously, i.e., they literally perfect one another. The elementary habits are not completed before the higher-order habits begin to form. The development of the higher and the perfection of the lower go hand in hand, throughout the whole course of the learning. Lower-order habits are developed in and through the formation of the higher as a further development of the higher is dependent upon the careful and final perfection of the lower.

3. This simultaneity of development does not mean, however, that all the habits of manipulation are making steady gains at the same instant. While all develop together they are not actually driven abreast. The gains made within the realm of each individual association is, like the general progress in learning, unsteady and irregular. The growth and development of the several special habits is something like the movement of a flock of sheep along a country road. The whole flock moves forward, now faster, now slower, while now this now that particular sheep pushes ahead of the rest. In learning typewriting all associations involved are making progress almost from the

first. Over this vast array of possibilities of improvement the learner's attention moves, focusing now on this, now on that particular phase of the work and causing an adaptation or short cut to be made now in this, now in that part. Frequent relapses in all departments of the work occur and there is great irregularity in the development of each special association because of the way in which attention changes.

4. The final perfection of all the special associations involved in typewriting is a very slow and gradual process. A little attention and direction is needed and must be given for a very long time after the details seem to be completely self-regulative. This fact has two very important bearings on learning: (*a*) As the association becomes automatic it loses its attraction, or drawing power, for attention and becomes very hard to attend to carefully. (*b*) This affects the learner's attitude. He either gets lazy and lets attention drift to outside interests, or crowds ahead too fast, aiming at speed, and fails to give to the association the slight direction required to master it fully.

These facts make clear the meaning of the general course of the learning curves. Their first rapid rise is due to the fact that all orders and kinds of associations are developing simultaneously and that they are all in their first stages of development where growth is easy and rapid. The later slow and gradual rise is explained by the fact that many adaptations and combinations have been made, that those which remain are harder to make and that the final perfection of associations is itself such a slow and gradual process. The learning curves become almost horizontal as an expert skill is approached.

EXERCISE

1. What are some of the simple habits and some of the higher-order habits involved in an act of skill other than typewriting, e.g., tennis playing, billiard playing, driving a car?

7. RELATIONS BETWEEN HABITS

A[1]

BY JAMES R. ANGELL

We may roughly divide our habitual reactions into three groups, groups which are frankly arbitrary, but which will reasonably serve the practical purposes of our present business. There is (1) the sort of thing to which the term is most often applied and to which the characterizations of a few moments ago are most germane: i.e., motor activities in which the significant feature is some change brought about by the movement in the physical world. Walking, running, talking, and writing may illustrate this group. Here the important thing is the overt external result of the act; the distance traversed, the word spoken or written, and so on. Next (2) may be mentioned habitual acts in which the purport of the act is to be found not in the mere external result, but in some sensation which the act facilitates, emphasizes, or renders possible. Here belong the habitual accommodatory movements by which we focalize our sense organs on stimuli to which we wish to attend. I turn my head to see an interesting object. I turn it in quite a different manner to hear the indistinct speaker. I give it still another shift, accompanied by certain accessory inspiratory movements, if I wish to get the full fragrance of a bunch of violets, etc. All these sensory activities involve motor accommodations of the habit variety: i.e., efficient muscular acts involving at present little or no conscious guidance. (3) Lastly there are certain ideational processes to which psychologists are sometimes hesitant to apply the term habit, because of the apparent absence of motor elements in some of them, but which certainly deserve it. The boy learning to use the multiplication table illustrates the point. As he becomes more and more expert, his mind executes arithmetical operations more and more automatically, until finally perhaps, here as elsewhere, the activity becomes essentially reflex.

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[1] Taken from "The Doctrine of Formal Discipline in the Light of the Principles of General Psychology," *Educational Review*, XXXVI (1908), 4-8. Doubleday, Page & Co.

The term "habit of thought" is applied to other forms of intellectual procedure with the intent sometimes to designate certain sentiments and prejudices, or again, to indicate that which is more nearly relevant to the present discussion: i.e., one's general methods of attacking a subject, the technique of one's thinking. The intellectual method which one acquires after a certain period of discipline in any field of thought—e.g., history, literature, economics, or commerce—will illustrate the case. One gets into a manner of dealing with such problems and bringing certain considerations to bear upon them which essentially merits the term habit, altho the operation may be considerably less mechanical and inflexible than is the case in the ordinary overt motor types of habits. Individual A always hunts for the details of his problem. Individual B has no interest in details, but always seeks at once the general bearings of the case. Individual C invariably lays out a systematic plan of campaign and follows it to the bitter end.

Individual D dips in anywhere and continues to dip without reference to any scheme of action. These illustrations may serve to make clear the point. Now on the basis of this cursory examination of certain typical manifestations of habit, let us consider the probabilities as regards the effects of general training, or the carrying over of facility from one sort of habit to another.

One kind of process which certainly goes on all the time, and which may have a remote bearing on the general point at issue, is the incorporation of smaller habits in larger habit groups. The child in learning to write has at first to give all his energy to the mere grasping and guiding of the pen. As dexterity is gained, the movement gradually comes to take care of itself and gets incorporated in another and larger coördination: i.e., the spelling-and-writing coördination. This in turn gets taken up into a "paragraph-construction habit," which in its own turn may be swallowed up by the chapter, article, or section habit. Not that this account necessarily follows any unchanging chronological sequence or is true of all persons, but that it illustrates what is generally true all along the line: i.e., that specific habits are constantly merged with other specific habits to furnish forth larger and more complex coördinations. This is true of each of the three forms of habit which we have distinguished, and illustrations will readily suggest themselves. Evidently it might well often occur that a habit acquired in some special study should find a place in a larger group of habits apparently quite disconnected from the study. This is peculiarly true, it may be added, of all the common studies of the elementary school.

It seems clear, too, that habits closely akin to one another may readily reinforce each other in a practical way, even tho the literal fact should prove to be that one or other is slightly modified in this case, rather than merely reinforced. For instance, a boy who has learned to play baseball and to judge accurately the position of a ball in the air, has a large part of the difficulty of certain strokes in tennis already conquered, despite the fact that the position which he must assume to meet the ball in the two cases is somewhat different. Here again we should on examination find that all our classes of habit would furnish illustrations of the principle.

On the other hand, certain habits are apparently inimical to certain others. In a general way we recognize this when we lay stress on the avoidance of contracting "bad habits" at the outset of any new undertaking. Such habits may be bad in the conventional moral sense, or merely in the technical sense that they limit efficiency. But in either case we feel such habits to be not only inherently undesirable, but also a menace to the opposed good habits and an added difficulty in the securing of the latter. Apart, however, entirely from the question of bad habits, so-called, there seems to be no doubt that certain habits, if they become thoroly ingrained, may go far to incapacitate their possessor from contracting in an effective way certain other kinds of habits. One who has learned to drive spikes with a sledge hammer will probably find it more difficult to learn to execute fine embroidery than would have been the case had he not received the sledge practice and contracted the sledge habit. Similarly, one who has learned to concentrate altogether on the *meaning* of the printed page, and especially one who has learned to combine this capacity with great rapidity of reading, finds it extremely difficult, if not impossible, to read proof accurately. And conversely, it may be doubted if any first-class proofreader ever succeeds in reading very rapidly and at the same time with understanding. Attention has to be differently directed to achieve the two ends.

That our tastes and capacities rapidly become limited to those which we choose to cultivate is of course a fact familiar in literature as well as in common life; but as this fact has a possible explanation somewhat irrelevant to our topic, we may pass it by without further comment.

In academic life what is so common as to observe that men who have confined themselves assiduously to some one field of intellectual endeavor become largely incapable of entering into other fields of interest? It is not simply that their tastes rebel at the attempt. The machinery of their minds has lost a certain flexibility which possibly was once possest. All of which seems to show that expertness in specific directions instead of carrying with it unmitigated blessings may be purchased at a very great price, the price of efficiency in other important directions. It must be frankly confest, however, that such instances are always ambiguous in the form in which we meet them in ordinary experience, because we have no reliable means of determining how far the outcome is due to native limitation of talent, or to the accidents of environment, and how much is justly attributable to the sheer undiluted effects of the special form of intellectual discipline pursued.

This brings us fairly to the question whether there are any generalized habits? Or, are all habits essentially specific? In the habits by which we accommodate our sense organs to things to which we wish to attend, the process is apparently highly specific, and any gain in the efficiency with which we use one sense organ, say the eye, resulting from the use of another, say the ear, must spring from some central factor common to the use of the two, of which no mention has as yet been made. Similarly, the habits which consist in effective manipulations of external objects have for the most part a highly specific character. One who has learned to hammer skilfully can drive nails or tacks with equal deftness perhaps, but sawing requires a quite different set of coördinations, and planing still another. Whether such habits will, on the whole, reinforce or inhibit one another can only be determined by actual test.

B[1]

BY EDWARD L. THORNDIKE

THE METHOD OF INFLUENCE OF SPECIAL TRAINING

To understand how best to secure what general influence any special training does have, we must learn when and how the improvement of one mental function does increase the efficiency of other functions. In the present condition of our knowledge, a complete and perfectly definite answer cannot be given to this question, but the following principles are sure enough for it to be wise for teachers to act upon them.

Through identical elements.—One mental function or activity improves others in so far as and because they are in part identical with it, because it contains elements common to them. Addition improves multiplication because multiplication is largely addition; knowledge of Latin gives increased ability to learn French because many of the facts learned in the one case are needed in the other. The study of geometry may lead a pupil to be more logical in all respects, for one element of being logical in all respects is to realize that facts can be absolutely proven and to admire and desire this certain and unquestionable sort of demonstration. Earning one's living for three months may make an improvement in self-reliance in general, for the feelings "I can do something, I have succeeded, I am not an incompetent," awakened by self-support are one feature of self-reliance in general. Obedience to one master may make an improvement in general obedience by teaching the possibility and desirability of obedience and self-denial. So in Kipling's story, *Captains Courageous*, a spoiled child who falls overboard from an ocean liner and is picked up by a fishing smack is made sensible and obedient forever after by his experience of necessary submission to the rules of life enforced by the Yankee captain.[1]

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[1] Taken from *The Principles of Teaching*, pp. 243–45. New York: A. G. Seiler, 1906.

Of the millions of situations with which life confronts us many are duplicates, many are identical in important features and still more have something or other in common. One business is in part identical with another business; the sciences overlap; the poet and the musician have somewhat the same task; the concrete habits adapted to life in the country are not all useless in the city; the situations of school are not much like those of the factory or farm but they are not totally different; the process of translating a sentence from Choctaw may have some community with the process of choosing a candidate on election day. Where the community is great, the possibility for the use in one process of ability gained in some other process is great; where the identical elements are but a fraction of the whole, the possibility is little.

These identical elements may be in the stuff, the data concerned in the training, or in the attitude, the method taken with it. The former kind may be called *identities of substance* and the latter, *identities of procedure.*

Identity of substance.—Thus special training in the ability to handle numbers gives an ability useful in many acts of life outside of school classes because of identity of substance, because of the fact that the stuff of the world is so often to be numbered and counted. The data of the scientist, the grocer, the carpenter and the cook are in important features the same as the data of the arithmetic class. So also the ability to speak and write well in classroom exercises in English influences life widely because home life, business and professional work are all in part talking and writing.

The identity is however not so great as the advocates of the disciplinary value of composition and language study would perhaps ask us to believe. To write "letters to a friend" or "stories about a day in the country" or "essays on the characters in 'The House of Seven

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[1] Such a case is perhaps more like fiction than truth, for as common an event in real life would be that the spoiled child would retain a grudge against the captain of the fishing boat and would work out his spite on his parents also, his last state being worse than his first.

Gables'" is not the same thing as to write an efficient business proposal, or to keep a physician's record of cases, or to make a captivating advertisement. Nor is the ability to speak in language classes identical with the ability to speak to jurymen in a law court or to persuade voters.

Identity of procedure.—The habit acquired in a laboratory course of looking to see how chemicals do behave, instead of guessing at the matter or learning statements about it out of a book, may make a girl's methods of cooking or a boy's methods of manufacturing more scientific because the attitude of distrust of opinion and search for facts may so possess one as to be carried over from the narrower to the wider field. Difficulties in studies may prepare students for the difficulties of the world as a whole by cultivating the attitudes of neglect or discomfort, ideals of accomplishing what one sets out to do, and the feeling of dissatisfaction with failure.

EXERCISE

1. Discuss some specific habits not mentioned in the readings which make one another more efficient, and some others which interfere with one another.

8. FEATURES OF ESTABLISHED HABITS[1]

BY G. F. STOUT

We may consider habit either as fully established or as in process of formation. Our chief concern is with the principle of growth through which habitual modes of thought and action come into being. But it will be convenient to note the chief features of permanently fixed habit. These are four in number: Uniformity, Facility, Propensity, and Independence of Attention. Let us disregard for the moment habits of thought and volition, and consider only that class of muscular actions which are called secondarily automatic. Such are dressing and undressing, and the various forms of acquired manual dexterity. (1) It is obvious that these acts repeat themselves under similar conditions with a regularity which may be called machine-like, as compared with the fluctuating and variable acts of the same complexity for which custom has not prepared us. To act from habit is to act mechanically and *quasi* instinctively. (2) A habitual series of movements is also more facile. To see this we have only to compare the slow and bungling efforts of the learner who is continually taking false steps and having to retrace them, with the sure and rapid procedure of the practised adept. (3) A rooted habit is also, as such, a conation.[1] We are prone to do what we are used to do. This holds good universally, where there is no more powerful counteracting motive. Every interruption to our routine way of doing things is felt as a disturbance and annoyance. "I conceive it to be a part of our constitution," says Reid, "that what we have been accustomed to do, we acquire, not only a facility, but a proneness to do on like occasions; so that it requires a particular will and effort to forbear it, but to do it requires very often no will at all. We are carried by habit as by a stream in swimming, if we make no resistance." Dr. Carpenter tells that he was "assured by a large outfitter that all his workwomen in a particular department refused to work for a fortnight, merely because they were required to make a slight alteration (not productive of the least additional trouble to themselves) in the pattern of a particular garment." In general, the proneness to action which has become habitual, manifests itself in two ways: (*a*) the more firmly fixed the habit the slighter the cue required to prompt the customary reaction, and in the same proportion the reaction is less liable to disturbance from accompanying circumstances; (*b*) when the customary course of action is interrupted or repressed by obstacles, or by the absence of some of its necessary external conditions, the propensity becomes a conscious desire, accompanied by aversion to the disturbing conditions. (4) It is a commonplace that habitual action tends to become automatic, i.e., to take place independently of attention. This follows from the general nature of the attention-process, which essentially involves a readjustment of the mental preformation to relatively new conditions. There are, however, certain difficulties and misapprehensions connected with this subject which need to be cleared up. The clearest examples of habitual action taking place apart from attention are those in which attention is otherwise occupied, as when a person knits, or plays on a musical instrument, and at the same time engages in conversation, or threads his way through a crowded street while absorbed in thought. It should be noted that in such instances the diversion of attention is probably never absolutely complete. The musician, for instance, is more or less aware that he is playing a piece of music, and the absent-minded walker is not utterly oblivious of the fact that he is in a crowded street and in motion.

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[1] Adapted from *Analytic Psychology* (4th ed.), I, 258–63. London: George Allen & Unwin, 1918.

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[1] A conscious tendency toward action.—EDITORS.

What can be asserted confidently is that in such cases there is no persistent and discriminating attention to the details of the action. This distinction helps us to understand another group of habitual actions which do not appear to fall into the state of secondary automatism, however much they may be practised. Fencing supplies a good instance in point. The most expert fencer cannot afford to allow himself to be absorbed in an irrelevant train of thought while he is engaged in a duel. On the contrary, the keenest watchfulness is required. The reason is that only certain component parts of the action have become thoroughly habitual; these do not of themselves require to be attended to. The practised fencer has not to think about the proper modes of thrusting and parrying; what requires attention is the tactics of his opponent. As soon as he discerns by sight or feeling the direction in which his antagonist's rapier is moving, the proper reply is made automatically. Thus attention is demanded for the proper combination of a series of movements which are severally automatic, a combination which has to be adjusted to constantly fluctuating conditions. The union of attentive adaptation to relatively novel circumstances with automatic adaptation to circumstances more uniformly repeated is found in all ordinary voluntary action. Thus the decision to blow out a candle may require attention, but the process of walking towards it and blowing is automatic. It has been urged that secondarily automatic actions are never necessarily automatic, because it is always possible for us to attend to them if we choose, and that, whether we attend to them or not, they retain the essential features of habit. Now, it is certainly true that the musician who plays automatically may also, if he please, play with attention. But the real question is, how far his action as a whole retains the same character. That it does so can scarcely be maintained. There are two cases to be considered. In the one, the performer does not attempt to direct his discriminating attention to the mechanical details of execution, so far as they have been provided for by preformed habit. If and so far as this is the case, the effect of attention will be seen in new features which are absent in the automatic performance, such as expression or "soul," and increased accuracy in the more difficult parts. This cannot be called a mere repetition with attention of what could take place equally well through habit. In the second case the performer deliberately attempts to attend separately to details which do not require attention. We may assert confidently that in proportion as this is so, habit is disturbed; there is loss of facility, rapidity, and uniformity; the attempt is essentially artificial, and it simply serves to disturb pre-established arrangements.

The general result of the preceding analysis is that established habit is independent of and exclusive of attention. But it must be remembered that we have so far considered only series of muscular movements, and that we have reserved for separate treatment habits of thought and volition. On the first blush it would seem that by their very nature thought and volition can never become in the proper sense habitual; they are essentially attentive adaptations to relatively novel conditions. But closer scrutiny shows that this apparent difficulty arises from a misunderstanding. When we speak of a "habit of thought" or a "habit of will," we do not mean that the special acts of volition or the special trains of thought which are determined by preformed custom, themselves possess the characteristics of habit. We have already seen that automatic processes may enter as component parts into a total process which as a whole is very far from being automatic. The inverse of this is seen in habits of thinking and willing. Here a comprehensive habitual tendency realises itself on special occasions by means of special processes which are not habitual. Let us take as an instance of a habit of thought the custom which certain persons have acquired of shaping their reasonings according to patterns with which they have become familiar in the study of formal logic. The typical schoolman naturally approached every theoretical problem in this manner. It was his habit to reason in formal syllogisms. He did so automatically, without conscious choice. But in the case of each new problem the application of this habitual method required special attention in proportion to its novelty. Another example is afforded by the deeply rooted habit of certain modern biologists, who explain the origin of the characters of living organisms exclusively by natural selection. This mental tendency has become automatic with them; but on the special occasions in which it comes into play a special exercise of ingenuity is required in bringing the general principle to bear on the particular case. When habits of this kind are regarded as without sufficient justification, they are called prejudices, and their existence is an obstacle to the reception of new truths independent of any difficulties connected with the proof of such truths by argument and evidence. What has been said of habits of thought applies, *mutatis mutandis*, to habits of volition. When we are so accustomed to submitting to a certain authority that we do so automatically, we none the less have to exercise our attention in following its commands, if they are obscure or self-contradictory.

EXERCISE

1. Analyze an actual act of thinking and indicate the more and the less habitual elements involved.

9. ETHICAL IMPLICATIONS OF HABIT[1]

BY WILLIAM JAMES

This brings us by a very natural transition to the *ethical implications of the law of habit.* They are numerous and momentous. Dr Carpenter, from whose *Mental Physiology* we have quoted, has so prominently enforced the principle that our organs grow to the way in which they have been exercised, and dwelt upon its consequences, that his book almost deserves to be called a work of edification, on this account alone. We need make no apology, then, for tracing a few of these consequences ourselves:

"Habit a second nature! Habit is ten times nature," the Duke of Wellington is said to have exclaimed; and the degree to which this is true no one can probably appreciate as well as one who is a veteran soldier himself. The daily drill and the years of discipline end by fashioning a man completely over again, as to most of the possibilities of his conduct.

"There is a story, which is credible enough, though it may not be true, of a practical joker, who, seeing a discharged veteran carrying home his dinner, suddenly called out, 'Attention!' whereupon the man instantly brought his hands down, and lost his mutton and potatoes in the gutter. The drill had been thorough, and its effects had become embodied in the man's nervous structure."

Riderless cavalry-horses, at many a battle, have been seen to come together and go through their customary evolutions at the sound of the bugle-call. Most trained domestic animals, dogs and oxen, and omnibus- and car-horses, seem to be machines almost pure and simple, undoubtingly, unhesitatingly doing from minute to minute the duties they have been taught, and giving no sign that the possibility of an alternative ever suggests itself to their mind. Men grown old in prison have asked to be readmitted after being once set free. In a railroad accident to a travelling menagerie in the United States some time in 1884, a tiger, whose cage had broken open, is said to have emerged, but presently crept back again, as if too much bewildered by his new responsibilities, so that he was without difficulty secured.

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[1] Taken from *The Principles of Psychology*, I, 120–27. New York: Henry Holt & Co., 1890.

Habit is thus the enormous fly-wheel of society, its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor. It alone prevents the hardest and most repulsive walks of life from being deserted by those brought up to tread therein. It keeps the fisherman and the deck-hand at sea through the winter; it holds the miner in his darkness, and nails the countryman to his log-cabin and his lonely farm through all the months of snow; it protects us from invasion by the natives of the desert and the frozen zone. It dooms us all to fight out the battle of life upon the lines of our nurture or our early choice, and to make the best of a pursuit that disagrees, because there is no other for which we are fitted, and it is too late to begin again. It keeps different social strata from mixing. Already at the age of twenty-five you see the professional mannerism settling down on the young commercial traveller, on the young doctor, on the young minister, on the young counsellor-at-law. You see the little lines of cleavage running through the character, the tricks of thought, the prejudices, the ways of the "shop," in a word, from which the man can by-and-by no more escape than his coat-sleeve can suddenly fall into a new set of folds. On the whole, it is best he should not escape. It is well for the world that in most of us, by the age of thirty, the character has set like plaster, and will never soften again.

If the period between twenty and thirty is the critical one in the formation of intellectual and professional habits, the period below twenty is more important still for the fixing of *personal* habits, properly so called, such as localization and pronunciation, gesture, motion, and address. Hardly ever is a language learned after twenty spoken without a foreign accent; hardly ever can a youth transferred to the society of his betters unlearn the nasality and other vices of speech bred in him by the associations of his growing years. Hardly ever, indeed, no matter how much money there be in his pocket, can he ever learn to *dress* like a gentleman-born. The merchants offer their wares as eagerly to him as to the veriest "swell," but he simply *cannot* buy the right things. An invisible law, as strong as gravitation, keeps him within his orbit, arrayed this year as he was the last; and how his better-bred acquaintances contrive to get the things they wear will be for him a mystery till his dying day.

The great thing, then, in all education, is to *make our nervous system our ally instead of our enemy.* It is to fund and capitalize our acquisitions, and live at ease upon the interest of the fund. *For this we must make automatic and habitual, as early as possible, as many useful actions as we can*, and guard against the growing into ways that are likely to be disadvantageous to us, as we should guard against the plague. The more of the details of our daily life we can hand over to the effortless custody of automatism, the more our higher powers of mind will be set free for their own proper work. There is no more miserable human being than one in whom nothing is habitual but indecision, and for whom the lighting of every cigar, the drinking of every cup, the time of rising and going to bed every day, and the beginning of every bit of work, are subjects of express volitional deliberation. Full half the time of such a man goes to the deciding, or regretting, of matters which ought to be so ingrained in him as practically not to exist for his consciousness at all. If there be such daily duties not yet ingrained in any one of my readers, let him begin this very hour to set the matter right.

In Professor Bain's chapter on "The Moral Habits" there are some admirable practical remarks laid down. Two great maxims emerge from his treatment. The first is that in the acquisition of a new habit, or the leaving off of an old one, we must take care to *launch ourselves with as strong and decided an initiative as possible.* Accumulate all the possible circumstances which shall re-enforce the right motives; put yourself assiduously in conditions that encourage the new way; make engagements incompatible with the old; take a public pledge, if the case allows; in short, envelop your resolution with every aid you know. This will give your new beginning such a momentum that the temptation to break down will not occur as soon as it otherwise might; and every day during which a breakdown is postponed adds to the chances of its not occurring at all.

The second maxim is: *Never suffer an exception to occur till the new habit is securely rooted in your life.* Each lapse is like the letting fall of a ball of string which one is carefully winding up; a single slip undoes more than a great many turns will wind again. *Continuity* of training is the great means of making the nervous system act infallibly right. As Professor Bain says:

"The peculiarity of the moral habits, contradistinguishing them from the intellectual acquisitions, is the presence of two hostile powers, one to be gradually raised into the ascendant over the other. It is necessary, above all things, in such a situation, never to lose a battle. Every gain on the wrong side undoes the effect of many conquests on the right. The essential precaution, therefore, is so to regulate the two opposing powers that the one may have a series of uninterrupted successes, until repetition has fortified it to such a degree as to enable it to cope with the opposition, under any circumstances. This is the theoretically best career of mental progress."

The need of securing success at the *outset* is imperative. Failure at first is apt to dampen the energy of all future attempts, whereas past experience of success nerves one to future vigor. Goethe says to a man who consulted him about an enterprise but mistrusted his own powers: "Ach! you need only blow on your hands!" And the remark illustrates the effect on Goethe's spirits of his own habitually successful career. Prof. Baumann, from whom I borrow the anecdote, says that the collapse of barbarian nations when Europeans come among them is due to their despair of ever succeeding as the newcomers do in the larger tasks of life. Old ways are broken and new ones not formed.

The question of "tapering-off," in abandoning such habits as drink and opium-indulgences, comes in here, and is a question about which experts differ within certain limits, and in regard to what may be best for an individual case. In the main, however, all expert opinion would agree that abrupt acquisition of the new habit is the best way, *if there be a real possibility of carrying it out.* We must be careful not to give the will so stiff a task as to insure its defeat at the very outset; but, *provided one can stand it*, a sharp period of suffering, and then a free time, is the best thing to aim at, whether in giving up a habit like that of opium, or in simply changing one's hours of rising or of work. It is surprising how soon a desire will die of inanition if it be *never* fed.

"One must first learn, unmoved, looking neither to the right nor left, to walk firmly on the straight and narrow path, before one can begin 'to make one's self over again.' He who every day makes a fresh resolve is like one who, arriving at the edge of the ditch he is to leap, forever stops and returns for a fresh run. Without *unbroken* advance there is no such thing as *accumulation* of the ethical forces possible, and to make this possible, and to exercise us and habituate us in it, is the sovereign blessing of regular *work*."

A third maxim may be added to the preceding pair: *Seize the very first possible opportunity to act on every resolution you make, and on* *every emotional prompting you may experience in the direction of the habits you aspire to gain.* It is not in the moment of their forming, but in the moment of their producing *motor effects*, that resolves and aspirations communicate the new "set" to the brain. As the author last quoted remarks:

"The actual presence of the practical opportunity alone furnishes the fulcrum upon which the lever can rest, by means of which the moral will may multiply its strength, and raise itself aloft. He who has no solid ground to press against will never get beyond the stage of empty gesture-making."

No matter how full a reservoir of *maxims* one may possess, and no matter how good one's *sentiments* may be, if one have not taken advantage of every concrete opportunity to *act*, one's character may remain entirely unaffected for the better. With mere good intentions, hell is proverbially paved. And this is an obvious consequence of the principles we have laid down. A "character," as J. S. Mill says, "is a completely fashioned will"; and a will, in the sense in which he means it, is an aggregate of tendencies to act in a firm and prompt and definite way upon all the principal emergencies of life. A tendency to act only becomes effectively ingrained in us in proportion to the uninterrupted frequency with which the actions actually occur, and the brain "grows" to their use. Every time a resolve or a fine glow of feeling evaporates without bearing practical fruit is worse than a chance lost; it works so as positively to hinder future resolutions and emotions from taking the normal path of discharge. There is no more contemptible type of human character than that of the nerveless sentimentalist and dreamer, who spends his life in a weltering sea of sensibility and emotion, but who never does a manly concrete deed. Rousseau, inflaming all the mothers of France, by his eloquence, to follow Nature and nurse their babies themselves, while he sends his own children to the foundling hospital, is the classical example of what I mean. But every one of us in his measure, whenever, after glowing for an abstractedly formulated Good, he practically ignores some actual case, among the squalid "other particulars" of which that same Good lurks disguised, treads straight on Rousseau's path. All Goods are disguised by the vulgarity of their concomitants, in this work-a-day world; but woe to him who can only recognize them when he thinks them in their pure and abstract form! The habit of excessive novel-reading and theatre-going will produce true monsters in this line. The weeping of a Russian lady over the fictitious personages in the play, while her coachman is freezing to death on his seat outside, is the sort of thing that everywhere happens on a less glaring scale. Even the habit of excessive indulgence in music, for those who are neither performers themselves nor musically gifted enough to take it in a purely intellectual way, has probably a relaxing effect upon the character. One becomes filled with emotions which habitually pass without prompting to any deed, and so the inertly sentimental condition is kept up. The remedy would be, never to suffer one's self to have an emotion at a concert, without expressing it afterward in *some* active way. Let the expression be the least thing in the world—speaking genially to one's aunt, or giving up one's seat in a horse-car, if nothing more heroic offers—but let it not fail to take place.

These latter cases make us aware that it is not simply *particular lines* of discharge, but also *general forms* of discharge, that seem to be grooved out by habit in the brain. Just as, if we let our emotions evaporate, they get into a way of evaporating; so there is reason to suppose that if we often flinch from making an effort, before we know it the effort-making capacity will be gone; and that, if we suffer the wandering of our attention, presently it will wander all the time. Attention and effort are, as we shall see later, but two names for the same psychic fact. To what brain-processes they correspond we do not know. The strongest reason for believing that they do depend on brain-processes at all, and are not pure acts of the spirit, is just this fact, that they seem in some degree subject to the law of habit, which is a material law. As a final practical maxim, relative to these habits of the will, we may, then, offer something like this: *Keep the faculty of effort alive in you by a little gratuitous exercise every day.* That is, be systematically ascetic or heroic in little unnecessary points, do every day or two something for no other reason than that you would rather not do it, so that when the hour of dire need draws nigh, it may find you not unnerved and untrained to stand the test. Asceticism of this sort is like the insurance which a man pays on his house and goods. The tax does him no good at the time, and possibly may never bring him a return. But if the fire *does* come, his having paid it will be his salvation from ruin. So with the man who has daily inured himself to habits of concentrated attention, energetic volition, and self-denial in unnecessary things. He will stand like a tower when everything rocks around him, and when his softer fellow-mortals are winnowed like chaff in the blast.

The physiological study of mental conditions is thus the most powerful ally of hortatory ethics. The hell to be endured hereafter, of which theology tells, is no worse than the hell we make for ourselves in this world by habitually fashioning our characters in the wrong way. Could the young but realize how soon they will become mere walking bundles of habits, they would give more heed to their conduct while in the plastic state. We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or of vice leaves its never so little scar. The drunken Rip Van Winkle, in Jefferson's play, excuses himself for every fresh dereliction by saying, "I won't count this time!" Well! he may not count it, and a kind Heaven may not count it; but it is being counted none the less. Down among his nerve-cells and fibres the molecules are counting it, registering and storing it up to be used against him when the next temptation comes. Nothing we ever do is, in strict scientific literalness, wiped out. Of course, this has its good side as well as its bad one. As we become permanent drunkards by so many separate drinks, so we become saints in the moral, and authorities and experts in the practical and scientific spheres, by so many separate acts and hours of work. Let no youth have any anxiety about the upshot of his education, whatever the line of it may be. If he keep faithfully busy each hour of the working-day, he may safely leave the final result to itself. He can with perfect certainty count on waking up some fine morning, to find himself one of the competent ones of his generation, in whatever pursuit he may have singled out. Silently, between all the details of his business, the *power of judging* in all that class of matter will have built itself up within him as a possession that will never pass away. Young people should know this truth in advance. The ignorance of it has probably engendered more discouragement and faint-heartedness in youths embarking on arduous careers than all other causes put together.

EXERCISE

1. What are the bases for our every-day distinction between forming habits and breaking habits? Is it not true that we cannot break a habit without forming a new one, and vice versa? And if that is the case, why should we sometimes speak of forming a habit and at others of breaking a habit?

CHAPTER VI

GENERAL FACTS ABOUT SENSATION

1. SENSE ORGANS AND THEIR STIMULI[1]

BY C. JUDSON HERRICK

In the further study of the nervous system as the apparatus of adjustment between the activities of the body and those of environing nature, our first task is the analysis of the receptors (that is, the sense organs); for these are the only places through which the forces of the world outside can reach the nervous system in order to excite its activity.

> "The world is so full of a number of things
> I'm sure we should all be as happy as kings."

But in order to attain this fortunate result it is necessary that we should be able to discriminate the essential from the unimportant elements of this environing complex, and to adjust our own behavior in relation thereto.

Protoplasm in its simplest form is sensitive to some sorts of mechanical and chemical stimulation. In fact, as we have seen, all of the so-called nervous functions are implicit in undifferentiated protoplasm. But the bodies of all but a few of the lowest organisms are protected by some sort of a shell or cuticle from excessive stimulation from the outside, and individual parts of the surface are then differentiated in such a way as to be sensitive to only one group of excitations while remaining insensitive to all other forms. Thus arose the sense organs, each of which consists essentially of specialized protoplasm which is highly sensitive to some particular form of energy manifestation, but relatively insensitive to other forms of stimulation. Each sense organ possesses, in addition, certain accessory parts, adapted to concentrate the stimuli upon the essential sensitive protoplasm, to intensify the force of the stimulus, or to so transform the energy of the stimulus as to enable it to act more efficiently upon the essential end-organ.

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[1] Taken from *An Introduction to Neurology* (2d. ed., reset), pp. 74–79. Philadelphia and London: W. B. Saunders Co., 1918.

Sherrington states the distinctive characteristic of the sense organs in this form, "The main function of the receptor is, therefore, to *lower the threshold of excitability of the arc for one kind of stimulus and to heighten it for all others*." The selective function of the receptors is illustrated by a consideration of the different forms of vibratory energy which pervade the environment in which we live.

There are, first, rhythmically repeated mechanical impacts perceived through the sense of touch. This series of tactile sensations extends from a single isolated contact at one extreme to rhythmically repeated contacts touching the skin as frequently as 1552 vibrations per second.

A second series of vibratory phenomena is presented by the mechanical vibrations of the surrounding medium perceived subjectively as sound. Out of the entire series of such vibrations of all possible frequencies the human ear is sensitive to a series of approximately ten octaves from about 30 (in some cases 12) to about 30,000 (in some cases 50,000) vibrations per second (wave lengths from 1228 cm. or 40 ft. to 1.3 cm. or .5 inch in length). To all other vibrations it is insensitive. Within this range the average human ear can discriminate some 11,000 different pitch qualities (Titchener).

Subjectively, the series of tone sensations is broken up into a number of octaves, and it is found that a given tone of the musical scale is excited by vibrations of exactly twice the frequency which excites the corresponding tone of the next lower octave. By analogy with this arrangement all series of physical vibrations are sometimes spoken of as divisible into octaves, the octave being defined as those vibration frequencies which lie between a given rate and twice that rate or half that rate.

A third type of vibratory phenomena is presented by the much more rapid series of so-called ethereal vibrations, or waves in immaterial media. The lower members of this series are the Hertzian electric waves; the higher members are the *x*-rays. Between these extremes lie waves perceived as radiant heat, the light waves, and the ultraviolet rays of the spectrum. This series of ethereal vibrations may extend farther indefinitely both downward and upward, but of its ultimate limits we have no knowledge.

There is no human sense organ which can respond directly to the electric waves, the ultra-violet rays, and the *x*-rays. These have, accordingly, remained wholly unknown to us until revealed indirectly by the researches of the physical laboratories. Some ten octaves of this series are contained in the solar spectrum, from an infra-red wave length of about .1 mm. to an ultra-violet wave length of .00035 mm. The light from metallic arcs and from incandescent gases has, however, been found to contain wave lengths as short as .00006 mm. The human eye is sensitive to something over one octave of this series (waves from .0008 to .0004 mm. in length, whose rates lie between 400,000 and 800,000 billions of vibrations per second), with six octaves in the infra-red and three in the ultra-violet. The lower members of this series of vibrations of the solar spectrum, and to a less extent the higher also, are capable of stimulating the temperature organs of the skin.

Thus it appears that of the complete series of ethereal vibrations, we can sense directly only about one octave by the eye and a number of others through the sense organs for temperature in the skin, while to the lowest and highest members of the series our sense organs are entirely insensitive. The sensitivity of the skin to these vibrations is limited subjectively to a small range of temperature sensations, while the retinal excitations give us subjectively an extensive series of sensations of color and brightness. The human eye can discriminate from 150 to 230 pure spectral tints, besides various degrees of intensity and purity of tone, making a total of between 500,000 and 600,000 possible discriminations by the visual organs (von Kries). Some of the preceding data are summarized in the table[1] on page 184.

Similarly, the chemical senses, taste and smell, reveal to us only a very small number out of the total series of actual excitations to which our sense organs are exposed. Our organs of taste, in fact, can respond to only four types of chemical substances, with only four subjective sense qualities, viz., sour, salty, sweet, bitter. The organs of smell respond to a larger range of chemical stimuli and to far greater dilutions, *i.e.*, the threshold of sensation is far lower for smell than for taste.

Many of the lower animals have very different limits of susceptibility to the kinds of stimulation which we have just been considering,

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[1] In the preparation of this table I have been assisted by Professor R. A. Millikan, of the University of Chicago, whose kindness I gratefully acknowledge. The figures given are based upon the formula—

$$\frac{\text{velocity}}{\text{wave length}} = \text{rate}$$

and the velocity of transmission is taken as 3×10^{10} cm. per second. The actual velocity of light waves as worked out experimentally by Michelson is 299,853 kilometers per second.

and in some cases they have sense organs which are attuned to respond to a quite different series of environmental factors than are our own, as, for example, the lateral line sense organs of fishes. We can form no idea how the world appears to such organisms except in so far as their sensory equipment is analogous with our own.

TABLE OF PHYSICAL VIBRATIONS

Physical Process	Wave Length	Number of Vibrations per Second	Receptor	Sensation
Mechanical contact	....	From very slow to 1552 per second	Skin	Touch and pressure
Waves in material media	Below 12,280 mm.	Below 30 per second	None	None
	12,280 mm. to 13 mm.	30 per second to 30,000 per second	Internal ear	Tone
	Above 13 mm.	Above 30,000 per second	None	None
Ether waves	∞ to .1 mm. (electric waves)	0 to 3000 billion (3×10^{12})	None	None
	.1 mm. to .0004 mm.	3000 billion (3×10^{12}) to 800,000 billion (8×10^{14})	Skin	Radiant heat
	.0008 mm. to .0004 mm.	400,000 billion (4×10^{14}) to 800,000 billion (8×10^{14})	Retina	Light and color
	.0004 mm. to .000059 mm. (ultra-violet rays)	800,000 billion (8×10^{14}) to 5,100,000 billion (5.1×10^{15})	None	None
	.0000008 mm. to .00000005 mm. (*x*-rays)	400,000,000 billion (4×10^{17}) to 6,000,000,000 billion (6×10^{18})	None	None

From these illustrations it is plain that the sensory equipment of the human body is adapted to respond directly to only a limited part of the environing energy complex, the remainder having little, if any, practical significance in the natural environment of primitive man. During the progress of the development of human culture mankind has very considerably widened his contact with the environment by artificial aids to his sense organs. The range of vision has been extended by the microscope and the telescope, and of hearing by the microphone and the telephone. The photographic plate enables him to extend his knowledge of the solar spectrum beyond its visible limits, and the Marconi wireless apparatus brings the Hertzian electric waves under his control and thus enables him to put a girdle round about the earth in less than Puck's forty minutes.

We may conceive the body as immersed in a world full of energy manifestations of diverse sorts, but more or less completely insulated from the play of these cosmic forces by an impervious cuticle. The bodily surface, however, is permeable in some places to these environing forces and in a differential fashion, one part responding to a particular series of vibrations, another part to a different series, much as the strings of a piano when the dampers are lifted will vibrate sympathetically each to its own tone when a musical production is played on a neighboring instrument. The sense organs, again, may be compared with windows, each of which opens out into a particular field so as to admit its own special series of environmental forces. In each species of animals these windows are arranged in a characteristic way, so as to admit only those forms of energy which are of practical significance to that animal as it lives in its own natural environment.

The sensory equipment of the human race was thus established by the biological necessities of our immediate animal ancestors, and there is no evidence of subsequent improvement in these peripheral physiological mechanisms or of any increase in the number of our senses during the advancement of human culture. The advance in efficiency of the human race as compared with its brutish ancestors is to be sought rather in a more efficient central apparatus in the brain for the utilization of the sensory data for the welfare of the organism. What the progress of science has accomplished is to supplement the limited sensory equipment of primitive man by various indirect means. To recur to our analogy of a house with many windows, we have not been able to increase the number of windows so as to look out directly into new fields; but we have increased the range of vision through the old windows, much as a telescope brings remote objects near and as a periscope enables the observer to see around a corner. To the development of the cerebral cortex we owe the acquisition of these new powers which have opened to us the realms of electric vibrations, ultra-violet rays, and many other natural phenomena to which our unaided sense organs are quite insensitive.

EXERCISE

1. Explain what is meant by the quotation from Sherrington: "The main function of the receptor is, therefore, *to lower the threshold of excitability of the arc for one kind of a stimulus and to heighten it for all others.*"

2. Sensation As A Conscious Element[1]

BY EDWARD BRADFORD TITCHENER

The definition of sensation.—We have seen that "thinking" cannot go on without ideas. When I am thinking about anything, my consciousness consists of a number of ideas, some running their course side by side, and others following these in obedience to the laws of association. We have seen also that we cannot have certain ideas unless the body possesses certain organs; 'memory' and 'imagination,' *e.g.*, are very largely made up, for most of us, of visual ideas,—and these imply the existence of the eye.

Ideas[2] are always complex, made up of simpler factors. Our way of using a single word to express them—though there are good reasons for it—is likely to mislead us upon this matter: it tempts us to think that they are simple and uniform in their nature. Hence it requires some effort and trouble to analyse an idea, even if (as is often the case) it owes its existence to the combined action of several sense-organs. But every idea can be resolved into elements, *i.e.*, elemental *processes;* and these elements are termed *sensations*.

My idea of a particular book is an idea derived from the coöperation of several bodily organs. It may include at any moment the look of the book (eye), the sound of its contents when read aloud (ear), its weight (skin, etc.), and the scent of its cover (nose). Now let us leave out of account all the constituents of the idea except those which come from the eye. We have remaining the red of the leather and gold of the lettering on the cover, and the black and white of the printed pages. Each of these quite simple components of the idea is a *sensation* of sight. Or let us leave out of account all the constituents except those coming through the ear. We then have the sounds of a familiar voice, which we imagine to be speaking certain successions of words. Each word uttered has a particular pitch, is a particular musical tone; while at the same time its consonants are heard as noises or auditory shocks. These quite simple processes—the simple tone and the simple noise—are *sensations* of hearing. Or again: let us leave out of account all the components of the idea except the weight which we remember that the volume has when we hold it up. This weight includes a pressure on the skin of the hand, a pull or strain upon the tendons which hold the muscles of the arm to their bones, and a jamming together of the bones themselves at wrist and elbow-joint. Each constituent—skin pressure, tendinous strain, articular (joint) pressure—is a quite simple process, which cannot be further analysed. We speak, therefore, of *sensations* of pressure and of strain.

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[1] Adapted by permission from *An Outline of Psychology*, pp. 33–36. New York: Macmillan Co. Copyrighted, 1900.

[2] The term *idea* is used with slightly different meaning by different authors, but the manner in which it is here used will be sufficiently clear from the context.—EDITORS.

We have now split up the apparently simple 'book' into a large number of really simple sensations. The analysis was not easy, even though different bodily organs were concerned in the idea: it would be difficult to say, for instance, just what is due, in the idea of 'weight,' to joint, what to sinew, and what to skin. The analysis becomes very much more difficult when all the components of the idea come from the same sense-organ. Long practice is required before one can analyse the note of a musical instrument into the separate simple tones which it contains. But the analysis is always possible.

We may compare the sensation, the element of the idea, to the elements treated of in chemical science. The idea is a compound; it consists of a number of elemental processes, travelling side by side in consciousness: it therefore resembles the compound bodies analyzed in the chemical laboratory. But the sensation resists analysis, just as do the chemical elements oxygen and hydrogen. It stands to the idea as oxygen and hydrogen stand to water. Whatever test we put it to,—however persistent our attempt at analysis and however refined our method of investigation,—we end where we began: the sensation remains precisely what it was before we attacked it. 'Cold,' 'blue,' 'salt,' cannot be divided up into any simpler modes of experience.

All sensations come to us from definite bodily organs: cold from the temperature organs in the skin, blue from the sensitive organs in the retina of the eye, salt from sensitive cells planted in the mucous membrane of the tongue. These 'peripheral' organs,—organs at the periphery or on the surface of the body,—are united, by nerve-fibers, to the supreme "central" organ, the brain. The peripheral organs of temperature are united to one group of cells in the cortex (the grey covering matter) of the hemispheres of the brain; the retina of the eye to another; the peripheral taste-cells to a third. The bodily process with which sensation is connected is, therefore, twofold: it consists of a stimulation of the peripheral organ, and a consequent excitation (carried inward by nerve-fibres) of the central organ.

Our definition of sensation must take account of its simplicity as a conscious process (first part of the problem of psychology) and of its bodily conditions (third part of the problem). It will run as follows: Sensations are those elemental conscious processes which are connected with bodily processes in definite bodily organs.

We cannot get *any* sensation until the peripheral organ has been stimulated. Those unfortunates who are born blind or deaf, who have no peripheral organs which can be stimulated, possess no sensations of sight or hearing at all. It is a mistake to suppose that they live in darkness and silence. To appreciate darkness and silence we must be able to see and hear; darkness is a sensation of sight, and silence is in reality a very faint sensation of sound,—the sensation received from the pumping of blood through the arteries of the ear. Those born deaf or blind do not hear or see *anything*.

But when the peripheral organ has been stimulated some few times, its stimulation ceases to be necessary to the production of a sensation. The central excitation (set up somehow within the brain) is enough. We can 'remember' a yellow, when our eyes are shut; we can 'imagine' a cold draught, when our skin is thoroughly warm. The bodily processes connected with the remembered yellow and the imagined cold are central only, not peripheral; but the yellow and the cold, as mental processes, are none the less *sensations*.

"They are different from real sensations, however,—different from sensations set up by actual stimulation of the eye and skin," it may be said: "we know that they are only remembered or imagined, and not sensed." That is true; but the difference does not lie in the nature of the processes themselves. A remembered 'yellow' and a seen 'yellow' are just the same as sensations, as 'yellows.' If the remembered yellow seems to lack something of the seen yellow, that is only because its intensity is less, its outline not so distinct, its conscious course more rapid. Really, however, the 'remembered yellow' is a more complex process than the seen yellow: it is a yellow *plus* what we may call the memory-mark. So an imagined cold is a sensation of cold *plus* the imagination-mark.

3. THE CHARACTERS OF SENSATION[1]

BY JAMES SULLY

Distinguishable aspects or characters[2] of sensation.—The importance of the special senses depends on their possessing certain presentative aspects or well-defined characters, whereby they are fitted to be signs of qualities in external objects, as well as of the changes which take place in these. The sum-total of our knowledge of things is limited by the number of distinguishable characters among our sensations. We will first enquire into these distinguishable characters generally, and then briefly indicate their varying importance in the case of the different senses.

Intensity.—One obvious difference of character among our sensations is that of intensity. The difference between a bright and a dull light, a loud and a soft sound, is appreciated through what we call a difference of intensity in the respective sensations.

All classes of sensation, including the organic, exhibit differences of intensity. Those of the special senses exhibit them in greater number or finer gradation than other sensations. We cannot distinguish two shades of hunger as nicely as we can distinguish two degrees of intensity in the sensations of light and of sound. Such minute differences are intellectually important as a clue to the precise nature or structure of bodies, the degree of force exerted by them, their exact distance from us, and so forth. Thus a sensation of light of given intensity indicates (according to circumstances) a particular degree of brightness in an object (*e.g.*, a flame, a mass of snow), or its degree of proximity to the eye.

It is natural to ask whether these differences can be exactly estimated. An attempt has been made to do this. This has been by noting the correlations between intensity of sensation and strength or intensity of stimulus.

Relation of intensity to strength of stimulus.—As the student is no doubt aware, the physicist has special apparatus by which the exact quantity of certain at least of the stimuli of our senses, *e.g.*, luminous rays, can be estimated and varied. By help of such apparatus it has been found possible to apply a graduated series of stimuli to a sense-organ, and to note the precise effect of successive increments of the stimulus on the resulting sensations. These researches belong to the department of psycho-physics, a somewhat intricate branch of psychology requiring special study. Here it will be enough to indicate some of the more important of its results.

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[1] Adapted from *The Human Mind*, I, 86–94. New York: D. Appleton & Co., 1892.

[2] Often called *attributes.*—EDITORS.

Every stimulus must reach a certain intensity before any appreciable sensation results. This point is known as the threshold or liminal intensity of sensation.[1]

The situation of this point determines what has been called the *Absolute Sensibility* of an organ or part of an organ. Thus if two portions of the skin, A and B, differ in respect of their sensibility to pressure in such a way that a slighter force of impact (mechanical pressure) causes a sensation in the case of A than in that of B, we say that A has greater absolute sensibility than B.

When the threshold is passed an increase of the stimulus does not always cause an increase in the intensity of the sensation. A very slight increase (increment) may produce no appreciable effect. It is further found that the amount of increase of stimulus required to produce an appreciable difference in the sensation varies with the *absolute* intensity of the stimulus. Thus a very slight addition to a light-stimulus which would be sufficient to produce an increase of intensity in the case of a feeble sensation would produce no effect in that of a powerful one. Thus, let us suppose s and $5s$ to represent two stimuli of unequal intensity, and i a small increase. Then though the sensations produced by s and $s+i$ would be felt to differ the sensations produced by $5s$ and $5s+i$ might remain indistinguishable. The greater the intensity of the stimulus already at work the greater must be the increase of stimulus in order that a perceptible difference in the resulting sensation may arise. It is found that (within certain limits in the median region of the intensity scale) the required increment is directly proportionate to the intensity of the stimulus. Thus, whatever the value of s, in order to produce an increase in the intensity of the sensation, s must be increased by ks, where k stands for some constant fraction, as $\frac{1}{10}$.

These results may be expressed as follows: In order that the intensity of a sensation may increase in arithmetical progression, the stimulus must increase in a geometrical progression.[2] This is known as

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[1] It is sometimes spoken of as the threshold of consciousness, it being supposed that below this point there is an "unconscious" sensation.

[2] This fraction differs considerably for different sense-organs.

Weber's or Fechner's Law. The law has been found to hold good only within certain limits. It is much more clearly illustrated in the case of certain sensations, *e.g.*, those of light, than in that of other classes. Moreover, it is found that towards the higher and the lower extreme of the scale considerable deviations occur.

The famous generalisation of Weber, amplified and further tested by Fechner under the title of the Psycho-physical Law, has been since subjected to considerable discussion in the light of experimental researches. The result of these has been, on the one hand, to upset the claims of the Law to be a perfectly exact and universally valid principle, and, on the other hand, to establish the induction as *approximately* true within certain limits of intensity, the deviations at the two-extremes being accounted for by special physiological circumstances.

In addition to testing the validity of the principle, much discussion has been devoted to the interpretation of it. Fechner himself, as the name "psycho-physical" shows, gave it a psychological significance. That is, he supposed the nervous process to be simply proportional to the stimulus, so that the law formulates the relation of the former to the sensation. Wundt follows the same line, and seeks to bring the phenomenon under the psychological law of Relativity, *i.e.*, that our sensibility is of differences, not of absolutes. On the other hand, most recent writers on the subject adopt the alternative view that the law expresses a *physiological* relation, that is to say, that the need of greater increase of stimulus as the intensity rises in order to effect an appreciable change in the sensation is due to the properties of the nerve-structures.

Fechner, by taking the least perceptible difference between two sensations as his unit of intensity, and considering this to be identical in the case of all classes of sensation, supposed that he could quantify our sensations by regarding them as multiples of this unit. Such an attempt is now generally viewed as futile. We shall never be able to regard a given sensation as made up of so many units as we can regard a linear length or a mechanical force. Every sensation viewed in itself is an indivisible whole. What we are able to do is to compare different intensities and estimate the amount of their difference, and this can be done to some extent, but not in the exact way attempted by Fechner. Thus one may, judging by his own sensations alone, roughly place a weight, W^3, midway between a heavier and a lighter, W^1 and W^2, so that difference between W^1 and W^3 shall appear about the same as that between W^3 and W^2.

The magnitude of the fraction representing the increment of stimulus necessary to produce an increase of sensation determines what has been called the *Discriminative Sensibility*. The smaller the fraction the greater the discriminative sensibility. Thus the discriminative sensibility of the finger-tip to pressure is about twice that of the sensibility of the shoulder-blade, the fractions being approximately $\frac{1}{6}$ and $\frac{1}{3}$.

When the stimulus is increased up to a certain point any further increase produces no appreciable increase in the sensation. Thus a very powerful sound may be increased without our detecting any difference. Similarly in the case of a light-stimulus. We do not notice any difference in brightness between the central and peripheral portions of the sun's disc though the difference of light-intensity is enormous. Wundt calls this upper or maximum limit the height of sensibility of a sense. The higher this point in the scale the greater, according to him, the receptivity of the organ.

Finally, by taking together the threshold and height we have what Wundt calls the range of sensibility. The lower the former or minimum limit, and the higher the latter or maximum, the greater the range of sensibility. That is to say, the relative range is measured by a fraction, of which the numerator is the height and the denominator the threshold. It is important to add that these aspects of sensibility to stimulus do not vary together. Fechner ascertained that parts of the skin equal in respect of absolute sensibility to pressure differed considerably in discriminative sensibility. Nor does a high maximum limit or height necessarily indicate a proportionately large number of perceptible differences of degree. Discriminative sensibility is thus an independent aspect of sensibility, and by far the most important for intellectual purposes (knowledge of things).

Quality of sensation.—In addition to differences of intensity in one and the same kind of sensation, we have differences of kind of quality among our sensations. The group of sensations making up a particular sense, as those of sound, are marked off from other groups by a broad difference of *generic quality*.[1] This is the most obvious difference, and the one first distinguished. Owing to this disparateness or heterogeneity, the sensations of different senses cannot be compared one with another as different tones or colours can. It is only in rare cases, and more particularly in that of taste and smell, that such disparate sensations are ever confused one with another. These subjective differences answer to the broad differences in the process of physical stimulation and nervous excitation involved.

Next to these broad differences there are finer differences of *specific* quality within each sense. Thus there are the differences of quality answering to different colours in sight, to sounds of different pitch and of different timbre or musical "quality" in hearing, and so on. These subjective differences are, in certain cases at least, known to be correlated with differences in the *form* of the movement of the stimulus, *viz.*, rate of vibration or wave-length; and it is possible that these differences in the mode of stimulation produce corresponding differences in the form of that vibratory movement which constitutes the process of nervous excitation. These differences of quality are much sharper or more definite in the case of some sensations than in that of others. They are only very vague in the region of organic sensations, and are much less definite and easily distinguishable in the lower senses (taste and smell) than in the higher. Such differences, like those of intensity, serve as a clue to the properties of external objects. The difference between gold and iron is partly a difference of colour. Musical instruments, including human voices, are distinguished in part by their peculiarities of timbre.

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[1] Often called *modality*.—EDITORS.

As suggested above, it is doubtful what number of ultimate qualitative differences among our sensations we ought to assume. Certain sensations, as those of clang, which appear to the ordinary ear perfectly different one from another, are now known to have a common qualitative element (partial tone). These are cases where physiological analysis (resolution of the nervous conditions into a complex of processes) supplies what psychological analysis fails to supply.

It must not be supposed, however, that the mere discovery of a plurality of physiological processes proves the sensation to be made up of partial or constituent sensations. Thus the sensation of white may be produced by combining two luminous stimuli which separately would produce the sensations blue and yellow; yet we cannot say that the sensation of white *contains* the sensations blue and yellow. The two nervous processes may combine or fuse in a total process which gives rise to a new kind of sensation.

It follows that the attempts of Mr. H. Spencer and M. Taine to carry physiological or "objective" analysis so far as to resolve all differences of quality, generic as well as specific, into differences in the mode of combination of the same ultimate psycho-physical units ("nervous shocks") must be viewed as extra-psychological. For the psychologist those qualities are simple or ultimate which we cannot further consciously subdivide even with the help of a previous experience of the sensations which are known to correspond to a separate production of certain constituents of the whole nerve process involved.

Physiological conditions of quality.—The physiological conditions of quality have already been touched on. The generic differences, *e.g.*, those of sensations of smell, of sound, etc., are correlated with important differences in the mode of stimulation, as that between the action of ether vibrations or light on the retina of the eye and mechanical pressure on the skin. These physical differences in the external stimuli correspond, as we have seen, to physiological differences in the special organs. Each organ is specially constructed so as to react on a particular kind of stimulus.

Although we may in general regard the external process of physical action and the physiological process of nerve-excitation as correlated, the correspondence is closer in some cases than in others. Thus in the case of the so-called mechanical senses (touch and hearing) there is a closer correspondence between the course of the physiological process and the physical process than in that of the chemical senses (smell, taste, sight and thermal sense, or sense of temperature). In the case of these last the terminal apparatus at the peripheral end of the nerves appears to involve a more profound chemical process of transformation.

With respect to the physiological equivalents of specific differences of quality, we know certainly in the cases of sight and hearing that qualitative change in the sensation answers to a certain amount of change in the form (wave length) of the stimulus. And it seems reasonable to suppose that there are analogous differences answering to different olfactory and other special-sense stimuli.

A further question already touched on is whether, and if so how far, qualitative differences involve distinct nervous structures. We may suppose that the difference between red and blue, sweet and bitter, is correlated either with the separateness of the nervous elements (peripheral and central) involved, or merely with a difference of functional activity in the same elements. Modern research has gone to show that in certain cases, *e.g.*, sensations of hearing and of sight, there is a multiplicity of nervous elements engaged. On the other hand, it cannot be said that separateness of structure has been made out in the case of every ultimate difference of quality.

Relation of quantity to quality.—A difference of quality must be carefully distinguished from one of quantity or intensity. In some cases popular language appears to confuse the two. Thus we are apt to speak of a difference not only between gray and black, but between two shades of the same colour as if it were a difference of colour. In the region of touch it is probable, as we shall see, that differences in intensity of sensation give rise to the supposition of qualitative differences.

Quality is clearly distinct from quantity, and may in general be regarded as independent of it. That is to say, we can vary intensity without affecting the quality. This would appear to follow from the assumed dissimilarity of the underlying nervous conditions. At the same time this independence is not complete. After a certain increase in intensity quality becomes less distinct. Thus as all colours grow very bright they approach one another and tend to become whitish. It has often been remarked that the extremities of great heat and great cold tend to be confused one with another. On the other hand, where the intensity of a sensation is very weak its specific quality is apt to be disguised. Thus faint sensations of heat and pressure are difficult to distinguish one from another. It may be said generally that differences of quality only appear clearly when the sensations have a medium intensity.

Extensity: local distinctness.—Next to intensity and quality the most important feature of sensation is massiveness or extensity. It has already been pointed out that sensation varies quantitatively with the number of nervous elements stimulated. The extreme difference shows itself between an "acute" sensation, as that arising from the pressure on the skin of a pin point, and a "massive" sensation, as that arising from an extended pressure on the skin. Differences of extensity must be carefully distinguished from those of intensity. It is one thing to increase pressure at a point of the skin, another thing to spread a given degree of pressure over a larger surface. Extensity is thus a new quantitative aspect or dimension of sensation. There is more or less of sensation according as a larger or smaller sensitive area is acted upon. In certain cases, especially that of sensations of touch and sight, this extensity or extensive magnitude becomes definitely appreciable or measurable.

In this experience of a continuous extensity or spread of sensation we appear to have implicitly a number of distinguishable sensations. And common observation tells us that when two points of the skin sufficiently far apart are stimulated we do experience two sensations which have no tendency to coalesce one with another. This shows that sensations received by way of distinct and isolated nerve-fibres are (within certain limits at least) distinguishable one from another. This fact we will call the local distinctness of sensation. The physiological basis of the distinction is to be looked for partly in the fact of the insulation of the several nerve-fibres, and partly also in certain differences in the whole nerve-process which appear (in the case of the skin at least) to characterise stimulation of different points of a sensitive surface.

In order to understand this original aspect of sensation, extensity together with local distinctness, we must mark it off from that later *local* or spatial consciousness, which, as we shall see, is largely a product of experience. When we talk of primitive extensity we must not be taken to mean that an extensive sensation of colour or heat at the skin gives originally a consciousness of spatial extent or area. Nor must we include in the primitive "local" distinction of sensations a consciousness of spatial position or locality. It is probable that, with the firm layers of subsequent experience to pierce through, we cannot get down to this primitive aspect so as to imagine what it is like. Hence it is to be regarded not as a fact reached by analysis, but as a hypothesis which has a certain physiological support, and which is adopted as helping us to understand how the space-consciousness is developed.

Extensive magnitude and local distinctness of sensation are only found in a definite and precise form in the case of two senses, touch and sight. We do not appreciate extent or distinctness of points with any degree of clearness in the case of the organic sensations, the sensations of taste and smell, or even those of hearing. The probable reason for this seems to be that in the case of touch and sight we have special physiological arrangements which are wanting in the case of the other senses. These consist in the existence of a sensitive surface supplied by a system of isolated nerve-fibres arranged in a mosaic-like order, and so capable of being separately stimulated by properly-placed stimuli. The skin and the retina of the eye form such surfaces. In the case of the ear, although, as we shall see, there is probably some apparatus for securing a difference of sensation according to the direction of the sound, there is nothing answering to the retina with its multitude of points, any one of which can be acted on separately by a definitely-placed and rigidly-circumscribed light-stimulus.

Duration: protensive magnitude.—One other aspect of sensation may be just mentioned, *viz.*, duration or, as Hamilton has called it, protensive magnitude. Every sensation has a certain duration, being either momentary or persistent for an appreciable time. This duration constitutes a third dimension or direction of quantitative variation in addition to intensity and extensity. That is to say, we have more or less of a sensation either by altering the intensity, the extensity or spread, or the duration.

EXERCISES

1. Plot on cross-section paper a curve representing the relationship between sensation intensity and stimulus intensity where $k=1/10$. Divide the vertical axis, selected for sensation intensity, into equal segments and suppose that each division on this axis represents a sensation just appreciably more intense than the one below it. Represent stimulus intensity by the horizontal axis.
2. Which of the attributes or characters of sensation do you feel are most fundamental? Why?

4. THE FUNCTION OF THE SEVERAL SENSES IN MENTAL LIFE

A[1]

BY EDMUND C. SANFORD

In the following paragraphs the author attempts to sketch the functions of the several senses in the general mental economy, in somewhat the fashion in which a field naturalist might describe the rôles of the several forms of animal and vegetable life in some district under his observation. He begs the reader's indulgence, therefore, if he speaks first for a moment about well-known matters in order that both may start from common ground.

We have, as everybody knows, sensations of sight, hearing, smell, taste, and touch, sensations arising from posture and movement, and in addition, sensations of pain and indefinite general and organic sensations. We know that through these in various measure we receive impressions from the outer world and from our own bodies, that in response to data furnished by them we adjust ourselves to the world about us by means of movements and that in images derived from them we do a large part, at least, of our thinking.

Our first question is: *What part of these images, in which we do our thinking, does each sense furnish?* We are not especially interested to follow back the sensory elements to their utmost simplicity, but rather to study them in their combinations, in the perceptive and other complexes in which we always find them when we can actually observe them.

Let us take the senses one by one beginning with touch.

Touch is a sense world in itself. We group together under that name sensations of heat, cold, pressures and contacts, all of which show local differences as one part of the skin or another is stimulated. From the dermal surfaces we also get pain of a definite kind. In active touch we not only have these passive experiences, but a whole new set as well, giving us information as to the position and movements of our members.

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[1] Taken from "The Function of the Several Senses in the Mental Life," *American Journal of Psychology*. XXIII (1912), 59–65.

Passive touch is a sense of great immediacy. With the partial exception of heat and cold, it responds only to excitations that are applied directly to the skin itself and reach the nerves directly, or through but few intermediaries, as simple mechanical excitations. Mechanical stimuli must of course, like all other kinds, suffer transformation into nervous processes before they can reach the conscious levels of the central nervous system, but this simplicity and immediateness are not without their significance.

Touch resides in what is by far the most extensive of the sense organs,—the whole dermal covering of the body and much of the mucous surface,—and what is still more important, it has a very close and varied connection with the muscles. It has been plausibly conjectured that an important factor in the tactual "local sign" or special difference in character by which any given dermal impression is referred to the one part of the body surface to which it belongs, is a reflex tendency to bring the hand to the spot stimulated or to turn the eye so as to look at it. The same motor connection is shown by the violent start of surprise that follows an unexpected touch. There is hardly anything that will produce a more violent and general muscular contraction than a fully unexpected slap upon the shoulder. The shortness of touch reaction-times probably points the same way, as do, certainly, the variety of reflexes that follow dermal and mucous excitations. All this in the case of mere passive touch,—where the sensory surface simply receives what comes to it. With active touch the connection is still more intimate. The inner touch sensations (the capsular, muscle, and tendon sensations) are not only directly dependent upon bodily movements for their specific stimuli, but supply one of the handles by which we manipulate our members in voluntary movements. Interference with the usual inflow of sensations from the members in movement makes the movements themselves uncertain or impossible, except as vision serves as a vicarious guide. Touch, active and passive together, is pre-eminently the sense of closest motor connections. This also has its important meaning in the psychic life in general.

In another particular the sense of touch is peculiarly endowed. It is the only sense that has an organ that can be doubled upon itself.

The eye cannot see itself; the ear cannot hear itself; nor the tongue taste, nor the nose smell itself; but the hand can pass over the whole body surface, and in so doing both feel and be felt. The eye can, in a secondary fashion, see the body surface and follow and guide the movements of hands and feet, and the ear can hear and control indirectly the sounds that the vocal apparatus produces; but the touch surfaces alone can perform in perfection this ultra-philosophic feat of being at one and the same time both subject and object. The feelings of double contact that arise when two touch surfaces are brought together have, like the immediacy of stimulation and the close connection with muscular movement, a special meaning in the psychic life in general.

Touch has also other characteristics that are perhaps worth mentioning in passing, though their connection with our main problem is not so close. In power to stir emotion the sense stands high. A cool plunge into a swimming pool, the warmth of an open fire, a caress on hand or cheek, the kiss, the embrace, the shock of personal assault all testify to this. Touch is intimate; what stimulates our dermal surface concerns us closely. It touches us in more senses than one.

Touch is a sense in which man exceeds most of the animals. Others may excel him in keen discrimination of odors; perhaps others in vision; but few can compare with him in touch. It is hardly necessary to recall the general covering of fur, feathers or scales that most of the other animals have, and the inadequacy of fins, claws, paws, lips, or even of probosces, for fine palpations. And with the monkey tribe the hand, though ready in form for touching, is not yet free from general bondage to locomotion. There are a few exceptions. Prof. Whitman has showed an astounding sensibility to touch or jar in certain leeches; but as against most animals man's superiority still holds. Manual deftness in the surgeon or in the engraver is not alone a matter of eye and of muscle but of refined tactual sensibility as well.[1]

Touch is also a very ancient sense. It begins far back in the animal series, and is active from very early in the individual life history—

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[1] I remember reading many years ago of a cracksman who was able by touch to discover the combinations of the safe locks then in use. He scraped down one of his finger nails almost to the quick, and holding this against the lock was able to perceive the faint jars produced by the movements of the inner parts of the lock as each was brought to the point required for opening. To learn the combination was then but a matter of a few trials, and the safe was open. Whether this story is true, I do not know, but there is no prima facie impossibility in it. At all events the main point stands that the hand is not alone a tool-holding mechanism but a sense organ of high power.

at first in the tongue and lips, later in the hands and fingers. It is perhaps a mistake to regard it as the mother sense of all the other senses, as is sometimes done. The unicellular creatures react to light and chemical excitants as well as to contacts; and one is hardly justified in saying that everything comes from touch more than to say that everything comes from the primitive capacity to see or to taste and smell.

Nevertheless the statement seems to carry some truth with reference to two of the senses, the rotational-equilibrium sense and the auditory sense, both of which have their end-organs in the inner ear. The morphological series that connects the one with the other seems to have been made out with some exactness. The dermal surface first develops a little sensory pit which later in the series becomes closed in and sometimes contains a granule of calcareous matter. The organ thus formed serves indifferently as an organ for sensing bodily movements or for shocks and jars coming through the surrounding medium. To serve one of these functions come, in course of differentiation, the semicircular canals of the inner ear and their connected parts, still an organ for the indirect regulation of bodily movements, especially those involving rotation and the maintenance of equilibrium, and for the other, much later, the cochlea and the mechanisms responsive to the aerial jars that we sense as sounds. The functional relation is so close between the kinaesthetic organs of the inner ear and those of inner touch (the capsular, muscle and tendon senses) that the derivation seems not unnatural.

In the case of the auditory part of the ear the connection is much more remote. The auditory part of the ear is at most the granddaughter and not the own daughter of the sense of touch. And yet it maintains at one or two important points the family resemblance. It is still a mechanical sense and responds to actual mechanical impressions upon the nerves, though very delicate ones, and it is very closely connected with the general muscular system both in the central terminations of its special nerves, and in the outer physiological effects of its stimulation. A sudden and loud sound produces as violent a start of surprise and terror as an unexpected blow; babies wink at sounds long before they do to threats at the eye, and start and begin to cry at the slamming of a door. The auditory reaction-time is as short as the tactual, and probably for the same reason. And perhaps most interesting of all, rhythmically repeated sounds enter in through our ears and play upon our muscles for themselves, compelling us to keep time to them whether we will or not, and giving to rhythmically repeated sounds and movements the profound power over us which they undoubtedly exercise.[1] And finally hearing, like touch, is a sense that is always exposed to excitation and one that can obtain no mercy when within the range of its stimuli.

The differences are, however, no less fundamental. If the ear is still a mechanical sense, it does not require immediate contact with the sound-producing object; it receives at long range the air vibrations that betray the latter's presence; its sensations, therefore, bear a more objective and impersonal character. It tells us of events in the world at large and not so much of our own states and activities.

Because of the biological advantage of this long range function, the ear has gained in keenness and in variety of sensibility until its contribution to the mental life has reached large proportions. Because of the same refinement and range of sensibility it has become also a sense of indirect perception and of sensory inferences; we infer by their sounds many things which we do not otherwise sense; to take single instances, we know it is raining by hearing the patter of the rain on the roof, and the doctor diagnoses the condition of the organs of the chest from the sounds of heart and lungs. And the most important contribution of the ear to the mental life in general—one of transcendent importance—is in a measure but a further development of this habit of indirect perception—I mean the verbal signs of language, which it has developed in coöperation with its special motor partner, the voice. Of language I shall have more to say presently; I merely mention it here, and pass on to speak of vision.

Vision, like touch, is a sense of ancient lineage and of early development in the individual life. Like hearing it is a long range sense, taking note of things not directly but through the operation of the light which they emit or reflect. Unlike touch and hearing its connection with the general muscular system is not particularly close; but in compensation it has a tolerably complex motor apparatus of its own. In its original function as a light perceiving sense it is as far as possible from the mechanically stimulated sense of touch; and yet it has in the retina an extended sensory surface not unlike the skin, and this, with its correlated muscles, gives vision a certain physiological analogy to touch. From very early in life also it exercises a supervisory function with regard to that sense, and in course of time comes to be very closely bound up with it, and indeed fully to justify its description as "anticipatory touch." In giving us chiefly a spatial world of things, it also stands very close to touch—much closer than does hearing. But like hearing, again, it has developed an immense power of secondary or inferential perception, far more indeed than has the ear. It thus becomes the general business sense of the mental world; and can serve on occasion directly or indirectly in some degree in place of almost any of the rest. Things look hot or cold, rough or smooth, appetizing or disgusting, one is aided in understanding a speaker by watching his lips, etc., etc.

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[1] A slightly different example can be found in the effects of the crack of the whip and the pistol shots on the behavior of the big cats in Bostock's and other similar groups of trained animals. One can fairly see the sound stimulus playing upon the reluctant motor centers of the animals and forcing them to do in spite of themselves the things which the trainer requires.

In its own field its chief characteristic is the clearness and precision of its data. Beside it the other senses are dull and groping. It furnishes the very standard by which we measure intellectual comprehension. When a thing is as clear as day, i.e., as clear as seeing by daylight, it can be no clearer. This clear precision it probably owes, on the one hand, to the microscopic fineness of the retinal elements, and, on the other, to the dominant control that vision usually has over attention. Its contributions to the general mental life rest upon the three following qualities chiefly: that it is a long range sense, dealing with a world of outer things; that it is a sense that serves readily, though indirectly, for other senses; and that it is a sense that usually carries attention with it.

Of the senses of smell and taste there is little that need be said here. Smell is without doubt in man a survival—a sense that once stood high and is now for practical purposes almost negligible. Phylogenetically, and in certain creatures yet, it far outranks even vision as a long range sense. Under its influence it is probable that the development of the cerebral hemispheres themselves began. Time was when the nose was the organ of mind. It seems to have lost this leadership when man took his erect position and lifted his nose from the ground. For civilized man, at any rate, both taste and smell might be lost with very small inconvenience, though perhaps with some slight loss of pleasure.

Of pain and the general and organic senses we must say a little more. To pain it belongs more than to any other sense to mould behavior directly, though it works, in a negative way, forbidding, like the demon of Socrates, certain courses of action, without recommending others except by implication. In compelling power over attention it exceeds vision itself a hundred fold; and it gives to the mental life, as to life in any of its aspects, a color of stern reality. To treat my topic fully I ought to speak of this in detail, but I am not prepared to do so; it would take a book to discuss it adequately, and I must also for the rest of my space limit myself rather to the intellectual aspect of the mental life, and neglect the emotional and the volitional.

For much the same reason I shall have little more to say of the general and organic sensations than to remind you that they resemble in quality the various forms of touch; and that with the dermal and kinaesthetic senses, they form, on the one hand, the substance of our sensory experience of ourselves, and, on the other (as the sensory basis of emotion) the staple of our life of feeling.

B[1]

BY HELEN KELLER[2]

My hand is to me what your hearing and sight together are to you. In large measure we travel the same highways, read the same books, speak the same language, yet our experiences are different. All my comings and goings turn on the hand as on a pivot. It is the hand that binds me to the world of men and women. The hand is my feeler with which I reach through isolation and darkness and seize every pleasure, every activity that my fingers encounter. With the dropping of a little word from another's hand into mine, a slight flutter of the fingers, began the intelligence, the joy, the fulness of my life.

In all my experiences and thoughts I am conscious of a hand. Whatever moves me, whatever thrills me, is as a hand that touches me in the dark, and that touch is my reality. You might as well say that a sight which makes you glad, or a blow which brings the stinging tears to your eyes, is unreal as to say that those impressions are unreal which I have accumulated by means of touch. The delicate tremble of a butterfly's wings in my hand, the soft petals of violets curling in the cool folds of their leaves or lifting sweetly out of the meadow-grass, the clear, firm outline of face and limb, the smooth arch of a horse's neck and the velvety touch of his nose—all these, and a thousand resultant combinations, which take shape in my mind, constitute my world.

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[1] Adapted from *The World I Live In*, pp. 5–8. New York: Century Co., 1920.

[2] Helen Keller lost her sight and hearing during an illness when she was 19 months old. She is a graduate of Radcliffe College, and has gained considerable fame as a writer and speaker.

Ideas make the world we live in, and impressions furnish ideas. My world is built of touch-sensations, devoid of physical color and sound; but without color and sound it breathes and throbs with life. Every object is associated in my mind with tactual qualities which, combined in countless ways, give me a sense of power, of beauty, or of incongruity: for with my hands I can feel the comic as well as the beautiful in the outward appearance of things. Remember that you, dependent on your sight, do not realize how many things are tangible. All palpable things are mobile or rigid, solid or liquid, big or small, warm or cold, and these qualities are variously modified. The coolness of a water-lily rounding into bloom is different from the coolness of an evening wind in summer, and different again from the coolness of the rain that soaks into the hearts of growing things and gives them life and body. The velvet of the rose is not that of a ripe peach or of a baby's dimpled cheek. The hardness of the rock is to the hardness of wood what a man's deep bass is to a woman's voice when it is low. What I call beauty I find in certain combinations of all these qualities, and is largely derived from the flow of curved and straight lines which is over all things.

In my experience smell is most important, and I find that there is high authority for the nobility of the sense which we have neglected and disparaged. It is recorded that the Lord commanded that incense be burnt before Him continually with a sweet savor. I doubt if there is any sensation arising from sight more delightful than the odors which filter through sun-warmed, wind-tossed branches, or the tide of scents which swells, subsides, rises again wave on wave, filling the wide world with invisible sweetness. I never smell daisies without living over again the ecstatic mornings that my teacher and I spent wandering in the fields, while I learned new words and the names of things. The odor of fruits wafts me to my Southern home, to my childish frolics in the peach orchard. Other odors, instantaneous and fleeting, cause my heart to dilate joyously or contract with remembered grief. Even as I think of smells, my nose is full of scents that start awake sweet memories of summers gone and ripening grain fields far away.

The sense of smell has told me of a coming storm hours before there was any sign of it visible. I notice first a throb of expectancy, a slight quiver, a concentration in my nostrils. As the storm draws nearer, my nostrils dilate the better to receive the flood of earth-odors which seem to multiply and extend, until I feel the splash of rain against my cheek. As the tempest departs, receding farther and farther, the odors fade, become fainter and fainter, and die away beyond the bar of space.

I know by smell the kind of house we enter. I have recognized an old-fashioned country house because it has several layers of odors, left by a succession of families, of plants, perfumes, and draperies.

EXERCISES

1. Point out an important function of each sense without mentioning any of those functions described in Sanford's essay.
2. Indicate elements in the world of Helen Keller which are dependent upon the fact that she has been in communication with those who see and hear.

CHAPTER VII

VISION

1. THE ORGAN OF SIGHT

A. The Structure of the Eye[1]

BY PERCY GOLDTHWAIT STILES

All kinds of organisms are affected by light. Its influence upon the simpler forms, especially those not protected by pigment, is generally destructive. In less intensity it acts as a stimulus, modifying the behavior of the plants and animals upon which it falls. Some cells retreat from it while green plants grow toward its sources to utilize its energy in chemical syntheses. Quite low in the scale we notice animal types provided with what we call eye-spots, particles of peculiar substance which we believe to be more sensitive to the effects of light than the other protoplasm of their cells.

There is a great difference between being influenced by light and being able to see. To see we must have detailed pictures formed upon the retinas,[2] and we must have the requisite nervous and cerebral connections to make possible the analysis and interpretation of these pictures. If ground glass were kept before the eyes we could estimate degrees of light and might notice the coming and going of large shadows. It is probable that the visual powers of many organisms, snails, for example, are no better than this. We should be subject to the same limitations if the light fell directly upon our retinas without passing through the optical systems which refract and focus it.

The human eye is a camera. It is a globe about 1 inch in diameter with a small area projecting in front as though a second globe of less diameter were imbedded in the larger one. The region which projects beyond the regular curvature of the eyeball is exquisitely clear. It is called the *cornea*. The rest of the eyeball is white and nearly opaque. The eye is lodged in a deep recess of the skull. It has a cushion of fat behind it and six small muscles are inserted in it. The optic nerve runs back to the brain from a point which is not at the center of the eyeball but distinctly to the nasal side.

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[1] Adapted from *Human Physiology*, pp. 149–54. Philadelphia: W. B. Saunders Co., 1916.

[2] The inner coat of the eye.—EDITORS.

The eyeball is described as composed of three coats. The outer one is tough and dense; the cornea is a part of it. The middle coat is distinguished by the richness of its blood-supply; it seems to be specially concerned with nutrition. The innermost coat, reminding one of the plate or film in the camera, is the retina. It consists in part of nerve fibers which run from every region of it to the point of departure of the optic nerve. This nerve, in leaving the eye, necessarily perforates the middle and the outer coats.

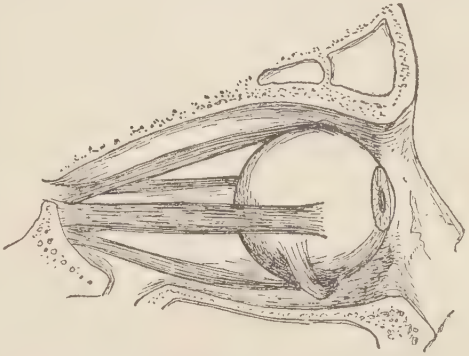

FIG. 36.—The right eyeball with some of its muscles in the shelter of the orbit.

The middle coat adheres to the outer everywhere but in front. Within the circle of the cornea it falls back and forms the *iris*, pierced by a round opening, the *pupil*. The iris is the part which gives the distinctive color to the eye. It is provided with muscle fibers adapted to narrow or to widen the pupil. The iris serves the same purpose as a diaphragm in a camera; it limits the admission of light when the illumination is strong and it has another use which will be pointed out presently.

Behind the pupil is hung the dense but elastic body which is called the *crystalline lens*. The name is somewhat unfortunate for it encourages the idea that this is the only lens in the optic system. In reality it has a smaller share in refraction than that borne by the cornea. It is of interest most of all because it is adjustable. It is convex on both surfaces but less so in front than behind. The presence of the lens separates the interior of the eye into a smaller cavity between it and the cornea and a larger one between it and the retina. Both these spaces are filled by fairly clear material, the *aqueous humor* before and the *vitreous humor* behind the lens.

Through the combined effect of the cornea and the crystalline lens a picture is made upon the retina. As in any camera the image is upside down. It is very foolish to make much of this fact, as people often do, for there is no reason why we should not become accustomed to the order of things we have always known and grow to regard the opposite relation as an inversion. One of the first lessons learned by a baby is to reach in a certain direction when an object makes a certain retinal impression. If the image is high on the retina he must reach down, while if it is low he must reach up. Without knowing anything at all about the retina he soon reacts unerringly.

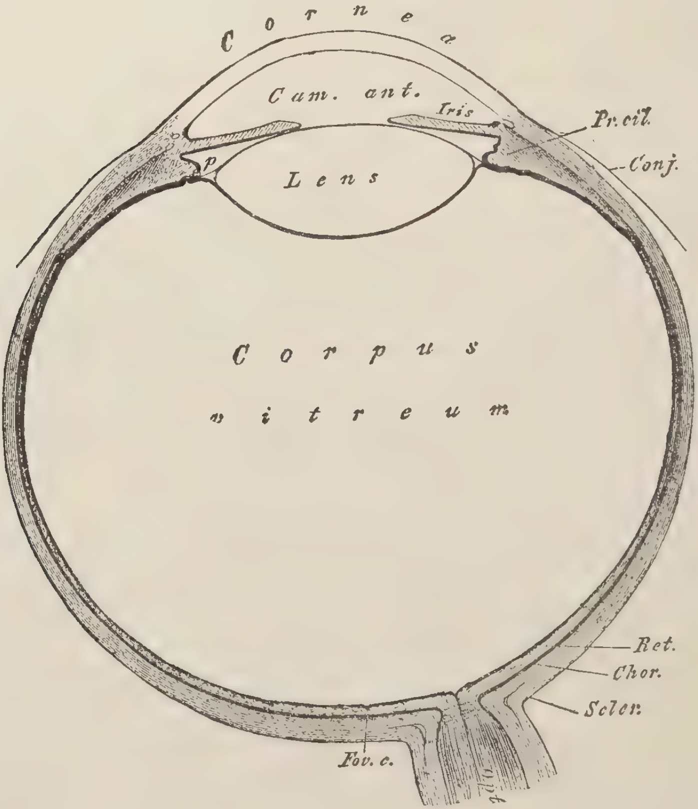

FIG. 37.—Horizontal section of the left eye (schematic, from Gegenbaur). *Scler.*, sclerotic coat; *Chor.*, choroid; *Ret.*, retina; *Opt.*, optic nerve; *Fov. c.*, fovea; *Pr. cil.*, the ciliary muscle or ciliary process; *Conj.*, conjunctiva; *Cam. ant.*, the anterior chamber; *Corpus vitreum*, the vitreous humor that fills the posterior chamber.

Accommodation.—A camera must be focused with reference to the distance of the features to be brought out in the photograph. If it has been used for a landscape and is next to be used for a portrait the plate must be set farther back from the lens. The same problem exists for the eye but it is not met by changes of depth. Instead, the lens is made to assume a more pronounced curvature, so far as its front surface is concerned, when the attention is directed toward anything near at hand. This is accomplished by the contraction of smooth muscle distributed in the middle coat of the eyeball in the region surrounding the iris. We cannot discuss here the mechanics of the act. The normal eye is defined as one which forms clear images of distant objects without effort. The act of accommodation is for near vision and has a limit which is easily discovered, the shortest distance at which we can clearly see details. When the attention is shifted to something far away the adjustment is a passive one; we do not speak of accommodation in this case but of the relaxation of accommodation.

It can be observed that when accommodation for near vision is employed there is a contraction of the pupil. This is explained as follows. In any lens that can be made the central part is more satisfactory for the formation of an image than the marginal part. In microscopes, telescopes, and cameras diaphragms are used to limit the passage of rays to the central portion of the lenses. The more convex a lens is, the more essential this restriction becomes. Therefore, when the crystalline lens has been rounded for the purpose of accommodation, it is desirable to make the pupil narrower than it may be when the lens is less convex. In technical language, the small opening is said to "diminish spherical aberration."

The extent to which the lens can be made to change its shape is greatest in childhood and is progressively lessened with the passing of the years. A man with normal eyes who has reached the age of forty-five usually finds that he cannot focus small type. He must begin to use convex glasses for reading. It should be pointed out that when he puts on his glasses he is adding to the total refracting power of his optic system and the principle of accommodation—extra convexity—is still utilized. The supplementary lens is placed in front of the eye when the lens inside can no longer be rounded up to meet the requirement. The loss of the capacity for accommodation which comes with advancing age is called *presbyopia*.

B. The Retina[1]

BY PERCY GOLDTHWAIT STILES

The retina.—It has been said that this coat of the eye is composed partly of the fibers which go to make the optic nerve. These fibers are not themselves directly sensitive to light. In fact the place where they converge to form the nerve is a so-called *blind spot.* We do not see the images of objects which are formed there. The fact that we are not troubled by this deficiency is to be explained chiefly by the circumstance that we are so much occupied with the central part of the retinal picture that we have little appreciation of the outlying part. It will be recalled that the optic nerve does not leave the center of the retina but makes its exit from a point some distance toward the nose. The central spot, before mentioned as having the best visual capacity, is called the *fovea.*

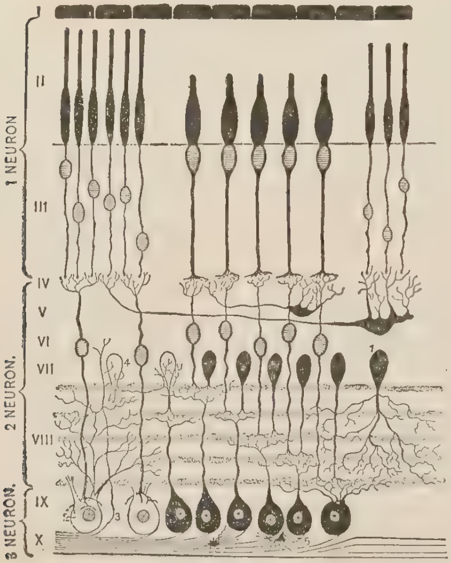

Fig. 38.—Diagram of the detail of the retina (Greeff from Howell). I, the pigment layer—the choroid coat; II, the rod and cone layer; III, the outer nuclear layer; IV to VIII, the layer of bipolar cells; IX and X, the ganglion cells and their nerve fibers which go to make up the optic nerve.

The student, when he reads a description of the several layers of the retina, has the strongest feeling that it is all "wrong side out." The cellular elements on which the light undoubtedly acts are not arrayed upon the inner surface but are on the outside, next to the middle coat. To reach them the light must pass through a tangle of nerve fibers and cells other than the true receptors. It must even pass a network of blood-vessels. The layer which finally translates the radiant energy into nerve-impulses is that of the *rods* and *cones.* At the fovea the overlying matter is reduced and the exposure of the sensitive units is correspondingly direct.

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[1] Taken from *Human Physiology*, p. 157.

The rods and cones constitute a mosaic pavement in which the individual members are placed with striking regularity. The cones are rather more advanced and elaborate in appearance than the rods and there is little doubt that they have superior properties. In the fovea there is a central group of cones with no rods, farther out the cones are scattered among rods which greatly outnumber them, and still farther from the fovea no cones but only rods are to be found.

EXERCISE

1. Study the structure of the eye until you can reproduce from memory the arrangement of its different parts.

2. THE PHYSICAL NATURE OF LIGHT

A. The Undulation Theory of Light[1]

BY WILLIAM THOMSON, ASSISTED BY CARL WEILAND

The rainbow may be regarded as one of the best examples in nature to show us not only the beauty of the pure colors but also the subjective aspect of them. Though the times have long gone by when Iris was thought to bring down along this path her message from the gods, nevertheless many people still regard the rainbow as an objective thing, and they wonder when scientists tell them that every person must of necessity see his own rainbow, differing from that of his neighbor not only in apparent size, according to the size of the observer, but also in its apparent position in the sky. And this may serve as a good illustration of the great difference between the old crude and the modern scientific view. Formerly all the qualities of the surrounding objects were regarded as something inherent in them, something that existed there independently of ourselves, whilst now we have learned to regard each quality in nature as a product of two factors, the *external object* and the *perceiving subject.* But this analysis is not always easy, and it seems especially difficult to separate the subjective and the objective factor with regard to colors; so difficult that artistic minds like Goethe's find it impossible to do so, and turn away with disgust from an analysis of our color-perceptions. Still, there is no escape from it, and it will be the object of this paper to review some of the most important facts with regard to the subjective and the objective aspect of colors. Of course, in the space allotted to this subject it will be impossible to go fully into details or to enter upon an exhaustive discussion of the different theories, especially in face of the fact that there are a good many questions still unsettled.

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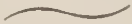
[1] Adapted from "Normal Color-Perception," *System of Diseases of the Eye*, I, 581–82. (Edited by William F. Norris and Charles A. Oliver.) Philadelphia: J. B. Lippincott Co., 1897.

First, then, *What is color objectively?* To answer this we must know what light is objectively. Light is regarded by modern physicists as a form of movement in a hypothetical medium, the ether. This is the undulation theory of light, which explains very completely all the phenomena so far observed. According to this theory, all the particles of ether along a ray of light are moving in straight or curved lines near their original points of equilibrium, like a pendulum, this movement occurring at right angles to the direction of the ray. As the movement of each succeeding particle occurs slightly later than that of the foregoing, it is clear that a line touching all the particles in their momentary positions, beginning at the first particle when this is just coming back to its original position and extending to that particle which just starts to move, must have a form like this: .

The distance between the end-points of this wave-line is called the wave-length, and is the smaller the sooner each particle completes its oscillation; whilst the velocity with which this oscillatory movement propagates itself in the air is the same for all wave-lengths, amounting to about one hundred and ninety-two thousand miles per second. If in a ray every particle of ether moves always through the same path with the same velocity, we call the light thus resulting monochromatic or homogeneous light: each particle takes then the same amount of time for its excursion. As soon, however, as, in another ray, the time of oscillation of each particle decreases, and as, therefore, the wave-length gets smaller, then again we get simple light, but of a different quality for our eye, or, as we express it, of a different color. Physically, therefore, color finds its equivalent in the number of oscillations per second, or the wave-length, and it has been found by experiment that light of the lowest number of oscillations of the ether particles and the greatest wave-length gives us red, while light of the smallest wave-length gives us violet. We speak here of greatest and smallest wave-lengths, but it must be understood that this refers only to those ethereal waves that are perceived by us as *light*. Indeed, the ether particles are capable of all kinds of oscillation, and in the ether waves of all lengths may be excited and propagated. The short waves seem to belong to the domain of electricity and magnetism. They do not seem to affect us directly; at least we have no special organ for their perception. They have been investigated by purely electrical methods. The longer waves affect our nerves in the skin and produce heat.

B. The Spectrum[1]

BY WILLIAM THOMSON, ASSISTED BY CARL WEILAND

Here we have to confine ourselves to those rays that affect our sight; and we have mentioned already the rays which contain only *one* kind of wave-length (from 750 to 380 $\mu\mu$),[2] the rays of monochromatic light. But the natural light of luminous bodies is not usually of one color. It contains in each ray waves of very many different lengths, so that we call it *mixed* or *compound* light, as each ray may be regarded as consisting of many rays of different monochromatic light. Such mixed lights we also have in the light of the sun. To prove that this is the case, we allow the white sunlight, after it has passed through a narrow slit, to go through a prism which has the property of bending the different rays differently, according to the wave-length existing in each. We find then the beautiful expansion of colors that is called the *spectrum*, extending from red, the least refracted light, through orange, yellow, green, blue, to violet, which is most deflected. These colors are so gradually changing one into the other that it is impossible not only to give to each color in the spectrum a certain definite breadth, but also to give names to all the different hues, of which more than one thousand could be distinguished by Aubert. But, as it has been possible to measure the wave-length of each part of the spectrum, we are always able to define a certain spectral color by saying that it must be of such and such a wave-length. We are also helped in this determination by certain dark lines in the solar spectrum,—Fraunhofer's lines,—the relation of which to the different colors with their different wave-lengths is given in the following table, combined from Helmholtz and Abney.

TABLE VII

Fraunhofer's Lines	Millions of Millions of Vibrations per Second	Wave-Length	Color
		$\mu\mu$	
A.	395	760	Extreme red
B.	437	686	Red
C.	458	656	Limit of red and orange
D.	510	589	Golden yellow
E.	570	526	Green
F.	618	486	Cyanean blue
G.	697	430	Limit of indigo and violet
H.	757	396	Limit of violet

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[1] Adapted from *op. cit.*, pp. 583–84.

[2] 1 $\mu\mu$ = one millionth of a millimeter.

According to the instrumental means employed, the spectrum can be made longer or shorter. If we regard such a short spectrum in its entirety, so that the whole affects our eye, it seems to be composed of only four colors,—*red*, *green*, *blue*, and *violet*,—because by contrast with these main colors their transitions into one another disappear almost entirely; at the most, one recognizes that the green becomes somewhat yellowish towards the red. If the spectrum is made longer, the transition-colors are better recognized, but they do not make their full impression on us if the other colors affect our eye at the same time. To study each color by itself, it must be isolated by shutting off all the other colors except one, which is allowed to go through a narrow shutter. By shifting this shutter along the spectrum all the different colors can be separately studied, and it is then found that nowhere is there any sudden gap in the color-series, but that all color-tones pass into one another continuously.

EXERCISES

1. What do you think is meant by a hypothetical medium? How can a disturbance or movement be propagated through something which is hypothetical?
2. Why is wave-length a more objective characteristic of light than is color?

3. CHARACTERISTICS OF COLOR

A. Hue, Purity, and Brightness[1]

BY WILLIAM THOMSON, ASSISTED BY CARL WEILAND

We are now in a condition to remark that all possible combinations of different luminous wave-systems of the ether lead only to a comparatively small number of different states of stimulation of the visual apparatus which appear in the different color-sensations. And in this sensation of each color we always distinguish three elements, or constants, as they are called, which are (1) *hue*, (2) *purity*, (3) *brightness*.

The first characteristic of any color is its *hue*, which tells us whether the color is red, green, blue, etc. This, in the spectral colors, depends physically, as we have seen, upon the wave-length of the ethereal vibrations in each ray, and thus we can use the two terms hue and wave-length promiscuously when we have to do with spectral colors. But we have rarely to do with spectral colors; mostly the natural colors are made up of several rays or groups of rays, and then we can compare the resulting color-sensation with the nearest spectral color of a definite wave-length, or for purple[1] and white with the nearest combination of two spectral colors, and thus define the hue.

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[1] Adapted from "Normal Color-Perception," *System of Diseases of the Eye*, I, 588–90. (Edited by William F. Norris and Charles A. Oliver.) Philadelphia: J. B. Lippincott Co., 1897.

The second constant of color is *purity*, called *tint* by Maxwell. We call a color the purer the less white is mixed with it. Purity must not be confounded with brightness, for many bright colors are not pure, but contain a large admixture of white; nor must it be thought that pure colors are always strong, rich, and deep,[2] for there are parts in the spectrum which, though of course perfectly pure, can be recognized only with difficulty. All pigments reflect also some white light, and so can never be perfectly pure, though colored papers in certain positions and colored worsteds in general may approach a pure color very nearly.

As the third constant or quality of color we must mention *luminosity* or *brightness* called *shade* by Maxwell. This factor depends objectively on the *vis viva* of the ether movement, and is therefore proportional to the square of the greatest velocity of the ether particles; but for us it depends not only upon the energy in the ether, but also upon the sensitiveness of our retina for the different colors.

B. The Color Pyramid[3]

BY EDWARD BRADFORD TITCHENER

Visual sensation.—There are two classes of visual sensations: colours proper, and "neutral colours" or brightnesses. The former class includes red, green, blue, etc.; the latter contains the blacks, whites and greys. The two kinds of sensation are intimately associated in our experience. We never see a colour that is not intermixed with a certain brightness; and we rarely, if ever, see a "neutral colour" that is not tinged by some true colour. We are thus led to introduce the word "saturation" into the terminology of visual sensation. The redder a red, the more of redness it has, the more "saturated" it is; the pinker or browner a red, the less redness it has in proportion to its white or black component, the less "saturated" is it. In the same way, we might call the black of velvet a more saturated black than that of black paper or cardboard; and the white of baryta paper a more saturated white than the white of ordinary note-paper.

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[1] Purple is a hue which cannot be found in the spectrum. It is present only when long and short rays (i.e., red and blue or violet) are mixed.—EDITORS.

[2] There are *psychological* terms, such as saturation and chromaticity, that refer to this strength, richness, or depth. From the standpoint represented by them, different parts of the spectrum, though equal in respect to *physical* purity, may differ in regard to saturation or chromaticity.—EDITORS.

[3] Taken by permission from *Experimental Psychology, Student's Manual*, Vol. I Part I, pp. 3–4. New York: Macmillan Co. Copyrighted, 1906.

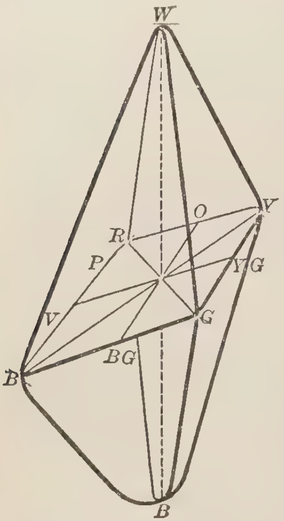

Fig. 39.—The color pyramid

The whole number of visual sensations is represented in Fig. 39. The dotted vertical *WB* corresponds to the white-black series; the base, to the most saturated colours,—red, orange, yellow, yellow-green, blue-green, blue, violet, purple. The following questions arise.

1) What do we find on the outside of the colour pyramid? What should we find if we peeled the whole figure, like an onion? What should we find upon a cross-section (plane of latitude)? Upon a longitudinal section (plane of longitude)?

2) Why do we take a quadrilateral figure (and not, *e.g.*, a circle) as the base of the double pyramid? Why is the base tilted, with the point *Y* highest and the point *B* lowest?

3) What determines the length of the sides *RY*, *YG*, *GB*, *BR*? What determines the angles *BRY*, *RYG*, etc?

4) Why is the *B*-pole rounded off at a lesser distance from the base than the *W*-pole?

It is clear that our visual sensations form a continuous, tri-dimensional manifold, and that any given visual impression can be adequately defined by the three properties of (*a*) colour or colour-tone (longitude), (*b*) brightness (latitude), and (*c*) saturation (distance from the axis).

4. THE LAWS OF COLOR MIXTURE

Color Mixture[1]

BY EDWARD BRADFORD TITCHENER

The dependence of visual sensation upon composition of light.—In tracing out the dependence of visual sensation upon the form or composition of light-waves, we may most conveniently employ the colour-mixer, with compound discs. Everyone knows that a glowing match, whirled round in the air, is seen as a fiery circle: the effect produced upon the eye by the moving stimulus persists for a time, in what is termed the positive after-image, until the stimulus comes back again to the same point. This is the principle which underlies the use of the rotating discs. It is, further, a law of physiological optics that if such parti-coloured discs are rotated at a rate of speed sufficient to prevent flicker, the resulting impression upon the eye is the same as it would be if the physical light, reflected from the several sectors, were spread uniformly, layer on layer, over the whole disc-surface. From this point of view, then, the use of the discs is as safe as it is convenient. Whether we may argue from the results obtained with the discs to the results obtainable with other forms of stimulus,—whether, more especially, we may argue from the disc-colours to the pure lights of the spectrum,—is a question which experiment must decide. We return to it presently.

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[1] Adapted by permission from *A Text-Book of Psychology*, pp. 67–70. New York: Macmillan Co. Copyrighted, 1909.

The facts to be considered in this section may be grouped under three laws, which are known as the laws of colour mixture. The first law states (1) that for every colour there may be found another, antagonistic or complementary colour, which if mixed with it in the right proportions produces a sensation of light, and if mixed in any other proportions a colour sensation, of low degree of chroma[1] and of the hue of the stronger component. Antagonistic colours, in this sense, are carmine and bluish green, red and verdigris, orange and greenish blue, yellow and blue, yellowish green and violet, green and purple. The second law states (2) that the mixture of any two colours which are not antagonistic produces a colour sensation of intermediate hue; this hue varies with the relative amounts of the two component colours, and the chroma varies with their nearness or remoteness in the colour series. Thus, a mixture of *Red* and *Blue* will give violet, purple or carmine, according to the amounts taken; and the mixture of *Red* and *Yellow* will give an *Orange* of relatively low, that of *Red-Orange* and *Orange-Yellow* an *Orange* of relatively high chroma.

These two laws are, evidently, laws of the same order; they sum up observations of the same general kind. The third law takes us a step farther and shows the effect of mixing, not single colours, but colour mixtures. It is sometimes termed Newton's law of colour mixture, since it is implicit in his theory of the composition of light. We may formulate it as follows: (3) if two colour mixtures arouse the same sensation of light or colour, then a mixture of these mixtures will also arouse that sensation. If, for instance, the grey produced by a mixture of carmine and bluish green is the same as that produced by a mixture of red and verdigris, then this grey will also result from the mixture, in the original proportions, of all four colours.—This third law enables us to answer in the affirmative the question, raised above, whether it is legitimate to argue from our disc-colours to other forms of visual stimulus, and especially to the pure lights of the spectrum.

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[1] Saturation or chromaticity; colorfulness.—EDITORS.

EXERCISE

1. What light does Newton's law of color-mixture throw upon the necessity for using pure spectral lights in experiments on color-vision?

5. ADAPTATION AND INDUCTION

A. Adaptation[1]

BY W. H. R. RIVERS

The two chief factors on which the excitability of a given area of the retina depends, are the nature of the preceding stimulation and the condition of the surrounding retina.

The condition of excitability of the retina, depending upon the nature of the stimulation, is called adaptation. The visual apparatus has the power of adjusting itself to differences of illumination, just as it has to differences of distance. The adjustment to differences of illumination depends on two factors,—the size of the pupil, and the condition of excitability of the retina.

Retinal adaptation was first studied by Aubert, who investigated the extent to which the sensitiveness to minimal stimulation was affected by complete exclusion of light from the eye. He found that the increase was rapid at first, the sensitiveness being multiplied many times in the first two minutes. The increase took place more slowly later, and the sensitiveness had almost reached its maximum in about twenty minutes, but continued to increase slightly for two hours, when it was very much greater than at first.

The retina is not only capable of adaptation to difference of luminosity, but also to differences of colour. The light which enters the eye is always more or less coloured. If coloured glasses are worn, the retina becomes adapted to the colour, and objects after a time again appear colourless. When the glasses are removed, objects appear coloured in the colour complementary to that of the glasses, and it is not till the eye has become again adapted to white light that objects appear colourless.

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[1] Adapted from "Vision," *A Text-Book of Physiology*, II, 1056–57. (Edited by E. A. Schäfer.) Edinburgh: Henry Frowde and Hodder & Stoughton, 1900.

B. After-Images (After-Sensations)[1]

BY W. H. R. RIVERS

When the adaptation is local, the appearances which occur are known as after-images, and may be seen in the absence of any objective light stimulus. When a limited surface is accurately fixed, it may appear to become brighter or darker according to circumstances; if coloured, it may appear to change in colour-tone, brightness, or saturation. If after a certain period of fixation the eyes are closed or directed to a grey surface, larger than the fixed surface, a part of the visual field will be seen, corresponding in form to the latter. This after-image may be of the same brightness as the original, or the reverse, and is known as positive or negative, in the same sense as in photography. If coloured, it may be of the same colour as the original, or it may be complementary. The term negative is often applied to the latter, but it is better to limit that term to denote brightness, and to speak of coloured images as homochromatic or complementary.

C. Positive After-Images[2]

BY W. H. R. RIVERS

Under certain conditions, a positive after-image is seen, which persists for a considerable time. It differs from the ordinary after-image in not undergoing the definite periodical variations of the latter, although similar irregular variations may be observed as it becomes faint. Such a positive image is seen with the dark-adapted eye, and may be very well seen soon after waking. It occurs with very short stimulation.

The most marked positive image is that which occurs after very intense stimulation. It is bright and well-defined when the eyes are closed, but appears as a dark cloud when seen against a bright surface. Its duration depends on the intensity of the stimulus, and it may persist for minutes or hours. In its later stages it may become coloured, and may also undergo irregular variations. In cases of very intense stimulation, a similar phenomenon has been observed to persist for very long periods, and even for life; and there does not appear to be any clear distinction between this definitely pathological phenomenon and the ordinary persistent image. The latter possibly only occurs when the stimulation has been sufficiently intense to disturb the normal functions of the retina.

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[1] Adapted from *A Text-Book of Physiology*, p. 1057.

[2] Taken from *op. cit.*, p. 1059.

Another phenomenon which has been observed with strong stimulation of the retina, is coloured waning of the after-image. The image of white light may be seen to appear in a succession of colours, beginning with bright greenish blue, passing on to blue, violet, pink, and then changing to a dirty orange and yellow-green. The exact nature of the coloration varies with the intensity and duration of the stimulus.[1] The colours have been referred to differences of persistence, and may also in some cases be connected with the colour adaptation of the retina.

D. Simultaneous Contrast[2]

BY CHARLES S. MYERS

Phenomena also occur owing to the influence which neighbouring areas of the retina always exert upon one another; they are effects of "simultaneous contrast." For example, a given patch of grey or of colour tends to be tinged in the colour complementary to that stimulating the rest of the retina; this is known as "colour contrast." It is most evident when the contrasting sensations are of equal brightness.

Again, a given surface (coloured or colourless) appears brighter or darker than it would otherwise appear according as it is brighter or darker than a neighbouring surface; this is known as "brightness contrast." Brightness contrast rapidly diminishes with increase of the distance between the two surfaces. Consequently, it is much more obvious when the one surface is smaller than, and completely surrounded by, the other, than when the two surfaces are equal and placed side by side. It can be experimentally shown that what is gained in brightness by the one surface is lost by the other. Brightness contrast is thus clearly due to mutual interaction in neighbouring retinal areas.

Brightness contrast is of course especially well-marked at the adjoining margins of the two surfaces. Here it subserves the important biological function of sharply outlining seen objects. For the retinal images of external objects must always have more or less ill-defined borders owing to the inevitable irradiation of light rays.

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[1] And also with the individual.—EDITORS.

[2] Adapted from *A Text-Book of Experimental Psychology* (2d ed.), Part I, pp. 75–76. Cambridge University Press; London, 1911.

Both brightness contrast and colour contrast may be intensified by increasing the extent or saturation of the larger surface, or by obliterating (*e.g.* by aid of the colour wheel) any differences in texture and the like between the two surfaces so that they appear as a single surface instead of as two separate surfaces.

EXERCISE

1. What single fundamental principle can be seen in all of the phenomena of adaptation, after-images, and contrast?

6. THE PURKINJE PHENOMENON[1]

BY MARY WHITON CALKINS

It will be well to summarize here the essential features of a characteristic color-phenomenon, often encountered in our study, under its historic name of "Purkinje phenomenon." As first observed, it consists simply in the fact that green and blue, seen in a faint light, have a greater intensity than red and yellow. This is illustrated by the familiar phenomenon that greens and blues keep their color in the twilight far better and far longer than reds and yellows; my bookshelf, for example, as the twilight falls, is a succession of intense greens and blues, broken by dull reds and yellows; as the room grows darker, the greens and blues stand out against lighter and darker grays, representing the reds and yellows; and even when these greens and blues have themselves turned to gray, they are distinctly brighter, more nearly white, than the reds and yellows.

A spectrum, therefore, regarded in a very faint light, is a series of grays, darkest at the red end and brightest in the region of green. Up to this point, the Purkinje phenomenon has been described, so far as it affects colors. In recent years it has, however, been shown by Ebbinghaus and by C. L. Franklin, that if two grays, one produced by the mixture of red and blue-green lights, and the other excited by the mixture of blue and yellow lights, be precisely matched in a bright light, the first of the two will grow brighter than the other in a faint light. Mrs. Franklin has suggestively named this observation an extension of the Purkinje phenomenon.

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[1] Adapted by permission from *An Introduction to Psychology*, pp. 478–79. New York: Macmillan Co. Copyrighted, 1904.

The significance of the Purkinje phenomenon has constantly appeared in discussions of color-theories. It is the most unambiguous psychological argument for the theory that the visual purple, and consequently the rods with which it is found, are organs of achromatic, or colorless light vision. For the Purkinje phenomenon appears only in faint illumination, and the visual purple is active only in faint light; moreover, the Purkinje phenomenon consists in the intensification of green and secondarily of blue lights, and the visual purple absorbs green rays—and, after green, blue rays—most readily; finally, the Purkinje phenomenon, as has been found, does not occur when the foveae of normal and partially color-blind eyes are excited, that is to say, it does not occur by excitation of the region of the retina which lacks visual purple and rods.

EXERCISE

1. What bearing has the extension of the Purkinje phenomenon demonstrated by Ebbinghaus and Mrs. Franklin upon Newton's law of color mixture? (See p. 217.)

7. COLOR-SENSE OF THE PERIPHERY[1]

W. H. R. RIVERS.

The colour vision of the peripheral retina has been investigated by many observers with very divergent results. The divergency depends to a very great extent on neglect of such factors as adaptation, the brightness and degree of saturation of the coloured light employed, the size of the area stimulated, and the nature of the background. The sensibility is generally tested by passing over the retina from periphery to centre, or *vice versá*, patches of coloured light, and noting, first, the limits where the different colours begin or cease to be perceived; and, secondly, the changes in colour-tone, saturation, or brightness which the patches appear to undergo. In general, it may be said that the brighter and more saturated the colour, and the larger the area stimulated, the greater is the distance from the centre at which a colour can be recognised. It is generally agreed that at ordinary intensities no colours are perceived at the extreme periphery, all being perceived as some shade of grey, depending on the kind of light and on the background; but, according to many observers, all colours can be recognised as far peripherally as white, if the light is made sufficiently intense.

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[1] Adapted from *op. cit.*, pp. 1084–85.

There is considerable difference of opinion on the question of the exact limits of the fields for different colours, but there is now fairly general agreement in placing the limits for blue and yellow distinctly outside those for red and green. Nearly all agree that the limits are not fixed, and are greatly influenced by intensity and the other factors mentioned.

Another important feature of peripheral colour vision is the change in tone which a coloured light appears to undergo as it passes over the retina from centre to periphery. Here again there is fairly general agreement that blue and yellow become colourless without undergoing any change in tone, while reds and greens pass through a stage in which they are seen as yellow or blue before becoming colourless. Violet is seen as blue, orange as yellow. Some observers, however, have seen yellow change to green peripherally.

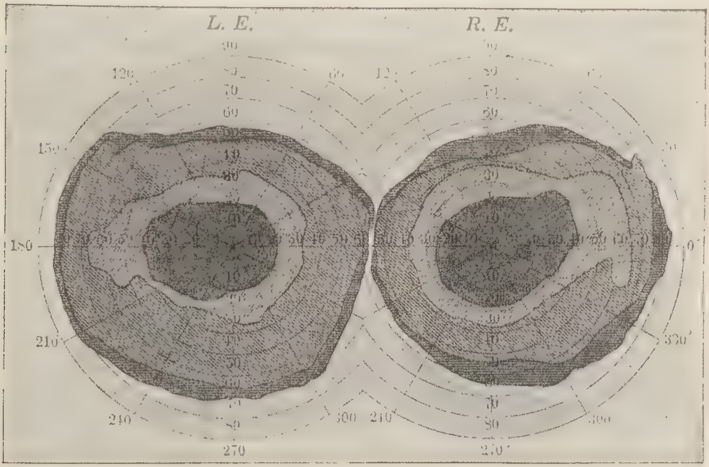

Fig. 40.—Chart of the color zones of the retinas. (From Breese.) The different outlines indicate the various color fields. On each retina the darkest inner zone indicates the field for green; the next larger (light grey) zone indicates the field for red; the next larger zone indicates the field for blue, and the large (dark grey) zone the field for yellow. The outermost zone responds only with sensations of colorless light; the portion of the retinas outside these is insensitive to light stimulations.

EXERCISE

1. Suppose that the capacity for seeing colors is a product of evolution. Judging from the color-senses of different parts of the eye, what was the order of appearance of the achromatic and chromatic qualities?

8. TYPES OF COLOR BLINDNESS

A. Color Blindness

Many persons are comparatively incompetent in applying names to colors. They are, for instance, likely to call certain greens "blue," or certain blues "green." Such persons need not be lacking or deficient in so far as the color sensitivity of their retinas is concerned. They make these errors rather because of incorrect associations between colors and color names due to insufficient experience with colors.

Color-blind persons, in the proper sense of the word, possess an actual ocular weakness or incapacity for sensing colors. Like those who have merely erroneous associations between colors and color names, the color-blind can with sufficient experience improve their ability to identify colors. Experience does not increase the sensitivity of their eyes, but it does teach them certain secondary criteria of color. The color-blind child to whom a field of ripened grain and a lawn look alike in regard to color, soon learns that one is "yellow" and the other "green." Different-colored dyes often give different surface textures to objects treated with them, and this furnishes a basis by means of which the color blind can apply color-names correctly. Certain colors, such as blue, are usually darker than certain other colors,

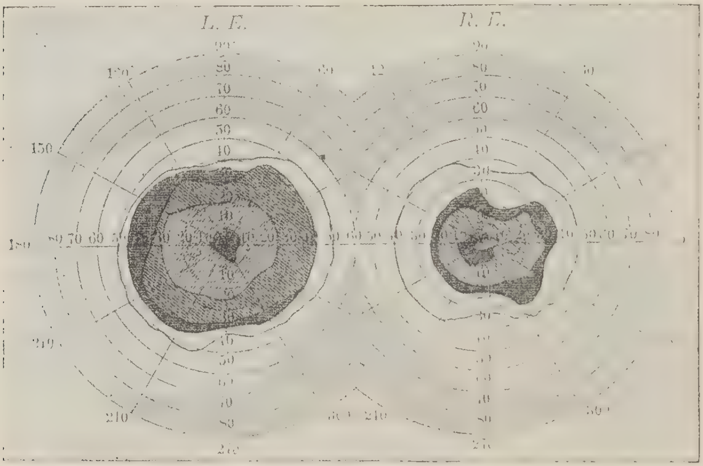

Fig. 41.—Showing the color fields in a case of defective color vision. Indications as in Fig. 40. (From Breese.)

such as yellow, and this furnishes still another basis for color discrimination.

Total color blindness, although rare, does sometimes occur. The spectrum to the totally color-blind eye is either all one color or entirely lacking in color—probably the latter. The different parts of the spectrum differ only in respect to brightness.

Partial color blindness is not at all uncommon. It is usually described as conforming to certain types, and these types may be taken as indicative of the general nature of most deficiencies of the color sense. There is some evidence, however, that most color-blind persons do not conform to these types very strictly. The first and most frequent type is red-green blindness. The long-wave half of the spectrum to the extreme red-green blinds probably appears yellow. The short-wave end appears blue. Between these regions is a so-called *neutral band* which appears gray. In certain cases the long-wave end of the spectrum is shorter than for the normal eye. In other cases it is of usual length. A very rare type of partial color-blindness is yellow-blue blindness. A number of cases conforming to this type have been reported, but only three or four have been carefully investigated. The extreme long-wave end of the spectrum appears red to such cases, as it does to the normal eye. In the region normally yellow, there is a band of gray. The green region appears green, the blue is gray, and the extreme short-wave end, normally violet, appears red.

B. Cases of Color Blindness[1]

BY B. JOY JEFFRIES

One of Dr. Colquhoun's patients says,

"I cannot perceive a bit of red sealing-wax if thrown down upon the grass, nor a piece of scarlet cloth hung upon a hedge, which, I was told, was to be seen a mile off. I once gathered some lichen, as a great curiosity, from the roof of a friend's fishing-house. I thought it was of a bright scarlet, from its seeming to be of the same color as the tiles; in reality it was a bright green. On another occasion I perceived no difference in the complexion of a foreign lady, who had purposely substituted Prussian blue for her rouge."

Dr. Nicholl says of a boy, eleven years old,

"I placed a scarlet paper on the grass, and afterwards a green baize. He said that the grass and the baize were of the same color as the paper, but that they were a shade lighter. I made him put on a pair of green spectacles, which he called *red* glasses. He said that everybody and everything in the room had a reddish cast when seen through them. The border of the room had a blue leaf with a green edge: this he called a blue leaf with a red border. A woman passed by with a basket on her arm. He told his mother that the woman had fowls in it, for that he saw the *red* feathers hanging out: these proved to be *green* leaves with which she had covered her butter. He told me, 'What you call purple and pink and blue are so like each other, that I cannot well know one from the other.' He also called the gray eyes of his sister a bluish red. A blood-relative of this lad was in the navy, and purchased a blue uniform coat and waistcoat with *red* breeches to match the blue. I showed him a doily which was red, having a leaf of the same color traced out on it, and I asked him the color of it. He, having been so often mistaken and laughed at, said with an air of triumph, 'Why the groundwork is red; but the leaf is, of course green.' "

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[1] Taken from *Color Blindness*, pp. 9–10, 15. Boston: Houghton, Osgood & Co., 1879.

Dr. Nicholl's second case, a gentleman forty-nine years old, said,

"If railings were painted red, I could not distinguish them from the grass. The grass in full verdure appears to me what other people call red; and the fruit on the trees, when red, I cannot distinguish from the leaves, unless when I am near it. A cucumber and a boiled lobster I should call the same color, making allowance for the variety of shade to be found in both; and a leek in luxuriance of growth is to me more like a stick of sealing-wax than any thing I can compare it with.' "

An architect reports having to release a pupil-apprentice in consequence of finding him copy a brown house in bluish-green paint, the sky rose-color, and roses blue.

A tradesman reports his boy offering pink and pale-green paper as good matches, and getting his master into frequent trouble by binding books in wrong colors.

A manufacturer reports that one of his weavers had to have the red and green threads selected by another, as he could not distinguish them.

A carver and gilder, who was color-blind, had a son who painted a head with a face muddy green, which he conceived to be vermilion. A brother of this person, an artist by profession, knew no difference by gaslight between the variously colored bottles in a druggist's window, and could not distinguish the red from the green signal-lamp at a railway-station.

C. A Case of Blue-Yellow Blindness[1]

BY FLORENCE RICHARDSON-ROBINSON

"The only case of color blindness of any note that I find in my father's family is Father himself.[2] The first time I learned of the fact was at a dinner party when Father lost his temper because one of the ladies told him there was a green stripe in his new suit. I learned from Mother afterward that it was always a sore spot with Father, and that if she wanted anything from a dry-goods store she always sent a sample along.

"In my Mother's family there are a number of well-defined cases. Of the 28 replies to inquiries that I sent out there were seven different cases spoken of. One, that of an uncle, was spoken of in nearly every letter, and it was a sort of a joke, in that he was reported to have seldom been seen with a mated pair of socks. He seemed to have no idea concerning either shade or color, and this was especially so in the case of fruit. He was probably totally color-blind. Another case was spoken of a number of times, a lady cousin unable to distinguish red and green. Another cousin wrote me that he could see colors if they were not too bright, but if they were very bright they all looked white. Another cousin wrote that he never knew he was color-blind until he took a railroad examination, but he thinks he sees color as well as any one. Of the others I remember very little of what they had to say. Besides the seven mentioned there were a number of others that admitted having difficulty with colors, but seemed unwilling to discuss it. Of the seven, four were men.

"A very peculiar condition existed in the case of one of my uncles who was not color-blind, but lost his sight entirely for about twelve years. He recovered it in his seventy-eighth year without medical aid.

"I learned when quite young to consider color blindness as a great defect, partly because Father often made unfortunate mistakes.

"The first difficulty that I can remember was to find out what people meant when they talked of the sky as blue. I remember when I thought that an apple must be red to be ripe, and I was perhaps six years old before I learned to tell by touch a ripe fruit, and even then I preferred it red. At home we raised three kinds of corn: red, yellow, and white. Red was red, white was smooth, and yellow was rough, and it was years before I could convince myself that a thing could be yellow, and not rough. White corn I could distinguish from yellow only by the shape of the ear, and the kernel. They looked alike in color. Questions often arose, but I dared not ask lest I expose my ignorance. I tried to solve the problem by remembering how a thing looked and felt that was spoken of as colored other than red, and by comparing texture and shade I experienced little difficulty under ordinary circumstances. The only difference between fresh cut grass and the bleached product was that the latter had lost its brilliancy. Standing grass was darker and had a surface that I associated with many other things people called green, though many of the things spoken of as green were to me nearly white. I could not understand why people spoke of a *golden* field of grain and a *green* hayfield, for they looked very much alike to me.

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[1] Adapted from "A Case of Color-Blindness to Yellow and to Blue," *American Journal of Psychology*, XXXIV, 159–61.

[2] This is the subject's description of his own case of color blindness.

"Paints I soon learned to distinguish, and seldom if ever get them confused as no two have the same kind of surface unless highly polished. Even blue in paints sometimes has texture, tho in other things it is usually so bright that I am unable to distinguish anything in its surface.

"At the age of fifteen I left the farm for a small academy and was obliged to work my own way. Railroading suggested itself to me as easy money, and to prepare for the examination I procured pieces of colored glass commonly used for signal lights and signboards, and set about studying them. I found that the texture of the glass was not the same as that of paint or of cloth. So I procured spools of silk thread and a sample card of house paints, and studied them. I took the examination and passed with but one or two minor errors. I went to work thinking I could tell colors as well as any one, but the eighth day I bumped up against the colored lights alone, ran a switch engine into a box car, and concluded that it was no place for me.

"Later when I entered college I found a complete change of conditions and it was here that I encountered my first real difficulties. I was working my way which was at times a severe tax on my system, and the first place to be attacked was my eyes, though only twice during my college work was my sight badly impaired for study and that followed continued loss of sleep.

"I took up chemistry as a freshman science and it was not long until I wished that I had not; however, I had started it and had too much *Dutch* blood to quit. I soon found that there are other characteristics just as distinctive as color. There were colored salts, solutions, flames, and precipitates. Flames were easy, as no two things volatilize at the same temperatures and their texture is entirely different. Copper and barium are both green, but otherwise are not nearly so much alike as barium and strontium, the barium being very soft and the copper hard, almost flinty.

"Precipitates were not so bad unless in a colored solution, as they all have a definite texture as well as a time for precipitation. Salts are not so important as far as color goes, but as for solutions I have never been able to find a way of telling their colors that was reliable, principally because they are transparent and one cannot see their surface.

"My plan was always where possible to note other characteristics than those of color, and as far as I know I have been just as successful in analytical chemistry as the rest of the class. I can see red in very small amounts (except in very strong light) better, I am sure, than most people, and green in dark shades in dull light. Blue is strong white with a glint to it, and yellow is usually a dull grey."

EXERCISE

1 If, as is sometimes claimed, color blindness is a condition of incomplete development of the essential mechanisms involved in color-vision, what form of color blindness would you expect to be most common? Why?

9. THE DUPLICITY THEORY[1]

BY M. LUCKIESH

This theory, which attempts to differentiate colorless and color vision, is chiefly associated with the name of Von Kries. It is based upon anatomical evidence of the existence of "rods" and "cones" in the retina. The former are assumed to be responsible for achromatic sensations and the latter for both achromatic and chromatic sensations. The rod action is supposed to be largely responsible for light sensation at twilight illumination and is in general more responsive to rays of shorter wave-length. The cones, however, are supposed only to act under stimuli of brightnesses represented by the range above twilight illumination and not to be greatly increased in sensitiveness by dark adaptation. Examination of the retina shows that the cones alone exist in the very center of the retina, the fovea centralis, and rods appear just outside of this and predominate in the outer zones. The chief observed facts that this theory explains fairly satisfactorily (perhaps because it was chiefly built up from these facts) are (1) colorless vision over the whole retina in dim light, for instance in moonlight, (2) the decreased sensitivity of the fovea in twilight, (3) the shift in the maximum of the luminosity curve of the eye (Purkinje effect) at low illumination, (4) the absence of such a shift for foveal vision, (5) no achromatic threshold is found for any light for foveal vision, (6) no achromatic threshold for red light for any region of the retina, and (7) colorless vision over the whole retina in the case of the totally color-blind. Some of the experiments with color-blind eyes further support the theory. For instance the luminosity curve for a totally color-blind eye at ordinary illuminations is similar to that for a normal eye for twilight vision. There are also evidences of diminished foveal sensibility, abnormally good vision in twilight, and decreased ability to fixate small objects with color-blind eyes. Further support is found in the presence of rods almost exclusively in the retinae of such nocturnal animals as the owl and bat. The supporting evidence in general is represented by more dependable and convincing data than in the case of any theory of color-vision. The "duplicity theory" does not attempt to explain color-vision, but is of interest here because of the attempt to separate vision into chromatic and achromatic processes.

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[1] Taken from *Color and Its Applications*, pp. 183–84. New York: D. Van Nostrand Co., 1915.

10. THEORIES OF COLOR-VISION

Color Theories[1]

BY BURTIS BURR BREESE

The difference between colorless and color-vision is explained by the theory that the former is the function of the rods, while the latter is attributed to the cones of the retina. But we have made no attempt to explain how the eye makes the further distinction of color-vision. What is the basis for the four elementary color-sensations? Are there four kinds of cones, one kind for red, one for yellow, one for green, and one for blue, each sensitive to light-waves of a certain length only? Such a theory is evidently too simple to explain the facts of color-vision. For example, how could we then explain the fact that certain colors, when mixed, produce colorless, while others give intermediate color sensations? Yellow and blue give gray, while yellow and red give orange. Furthermore, why does adaptation to yellow increase the sensitivity to blue and not to red? These and other facts show that the relation between the four elementary color-sensations is not uniform. A color theory must be able to explain all the facts of adaptation, complementary colors, after-images, color mixtures, contrasts, and color blindness. While a number of theories of color-vision have been proposed, no one has absolutely met this requirement.

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[1] Adapted from *Psychology*, pp. 190–96. New York, Chicago, Boston: Scribner's Sons. Copyrighted, 1917.

The Young-Helmholtz theory.—This theory, first proposed by Young and later modified by Helmholtz, is based upon the assumption that there are only three elementary colors—carmine red, slightly yellowish green, and ultramarine blue. It is supposed, according to this theory, that there are three photochemical substances in the retina, which correspond to these color-sensations. The red substance is chiefly affected by the longer waves (red waves); the green substance by the medium waves (green waves), and the blue substance by the shorter waves (blue waves) of the spectrum. All the color sensations together with white, are the result of the activity of these three retinal substances. Each substance is supposed to be affected somewhat by any light-stimulus, but *chiefly* by its own appropriate stimulus. Thus, while red light has its greatest effect upon the red substance, it also affects the other substances slightly. Equal excitation of all three substances gives the sensation of white. Any color would then have some white light (brightness) in it. This would account for the fact that colors are never completely saturated, or pure. Black is the absence of stimulation. Complementary after-images are due to fatigue of the photochemical substance stimulated. The other substances, then being fresh, react more powerfully to a gray stimulus, giving the complementary after-image.

Hering theory.—The Hering theory recognizes four elementary color-sensations, *red*, *yellow*, *green*, and *blue*, and two elementary colorless sensations, *white* and *black*. They exist in three pairs, the members of each pair standing in opposite or complementary relation to each other. The pairs are red and green, yellow and blue, and white and black. For each pair of sensations it is assumed that there is a single photochemical substance which has two antagonistic chemical processes—a dissimilative and an assimilative process. There are then three visual substances in the retina: a red-green substance, a yellow-blue substance, and a white-black substance. Red, yellow, and white light break down or cause dissimilation, while green, blue, and black light build up or cause assimilation in these three substances respectively. For instance, red light breaks down the red-green substance and green light builds it up. After the dissimilative effect of red light, the red-green substance tends to recover equilibrium, *i.e.*, assimilation sets in. This explains the green after-effect of red stimulation. Any color-stimulus not only acts upon its own substance, but also acts upon the white-black substance. This explains why all colors possess brightness. In case complementary colors (for instance, yellow and blue) act equally upon the yellow-blue substance at the same time, they neutralize each other, but, since they affect the white-black substance also, the result is a sensation of gray. If, however, these colors affect the white-black substance in equal but opposite ways, the retinal substances would all be in equilibrium, and the gray which results is supposed to be a cortical gray (a neutral or middle gray), which originates in the brain centre and corresponds to the absence of retinal activity. This neutral gray is supposed to be constantly present in vision and to mix with all visual sensations. Only when the given complementary colors affect the white-black substance in different directions unequally, or both affect it in the same direction, so that either assimilation or dissimilation takes place, is the resulting gray (light gray or dark gray), a retinal gray. The color zones of the retina are supposed to be determined by the presence or absence of the different substances. The cones of the innermost zone contain all three substances, those of the intermediate zone only the yellow-blue and the white-black substances, while those of the outermost zone contain only the white-black substance. Contrasts are due to the fact that any direct action of a stimulus on a part of the retina sets up a process of opposition in the parts not stimulated.

Ladd-Franklin theory.—Mrs. Ladd-Franklin has proposed a genetic color theory, which assumes that our present color vision is a development from a primitive stage of colorless vision. Such a condition now exists in the outermost zone of the retina, but the central portion of the retina has developed away from its original state, and now is able to produce color-sensations. The theory assumes a single photochemical substance in both the rods and cones. But in the rods it exists in its original, undifferentiated form, in which any light-stimulus whatsoever acts upon the molecule as a whole, breaking it down in all its parts and giving the sensation of gray. In some of the cones the elements of the molecule have been differentiated into two parts, such that one part is affected only by the longer waves of the spectrum and gives the sensation of yellow, while the other part is affected by the shorter waves and gives the sensation of blue. These cones are found in the intermediate zone of the retina. In the other cones, found only in the innermost zone, the yellow compound has been further differentiated into two groupings, such that red light affects one and green light the other. The three stages of development may be represented as shown in Fig. 42.

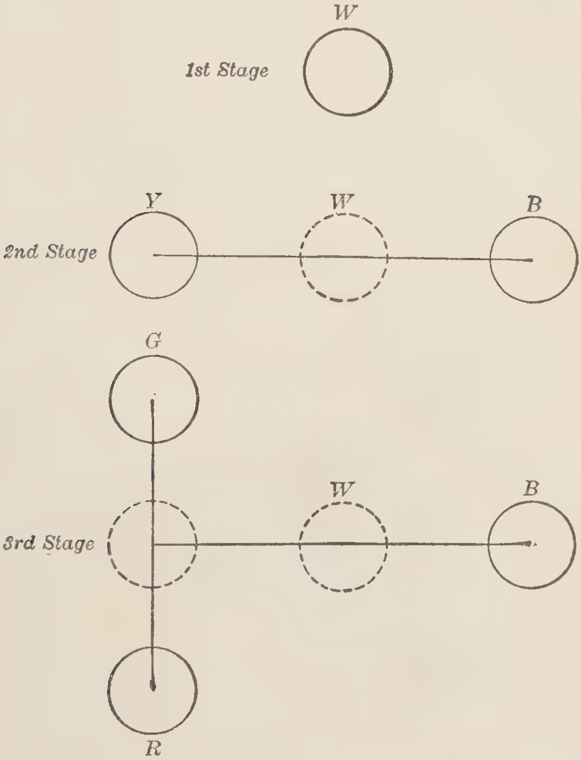

FIG. 42.—Scheme to illustrate the Ladd-Franklin theory of color-vision. After Ladd-Franklin.

In the first stage the photochemical substance acts as a whole. In the second stage the two parts may act separately. In the third stage the three parts may act separately. According to the theory, complete decomposition of the photochemical substance gives sensations of gray or white. Partial decomposition gives color. Thus, if both yellow and blue light act upon the yellow-blue cones, the result is the original sensation of colorless light, since both stimuli, when acting together, break down the molecules completely. If green and red act upon the green-red-blue cones, they arouse the sensation of yellow, but if green, red, and blue all act upon these cones, the original sensation of white or gray is aroused. If any color-stimulus acts alone, the molecules are only partially affected, and so produce sensations of color. One of the advantages of this theory is that it provides a common basis for peripheral gray, gray of very faint light, and the gray produced by mixing colors.

Many other theories have been proposed, but the theories mentioned are the representative theories, and they serve to show us the nature and the difficulties of the problem of color-vision.

EXERCISE

1. What weaknesses can you see in the foregoing theories?

CHAPTER VIII

THE AUDITORY SENSE

1. SOUND AND HEARING

A. The End-Organ and the Stimulus[1]

BY THEODORE HOUGH AND WILLIAM T. SEDGWICK

When the string of a violin, piano, or harp "sounds," one can observe that it is in rapid vibration; and the same thing is true of all sounding bodies. These vibrations are imparted to the air, water, or other surrounding medium, and through this medium they are transmitted as waves of sound. It is these waves, or vibrations, which, on entering the ear, excite the sensation of sound. The more

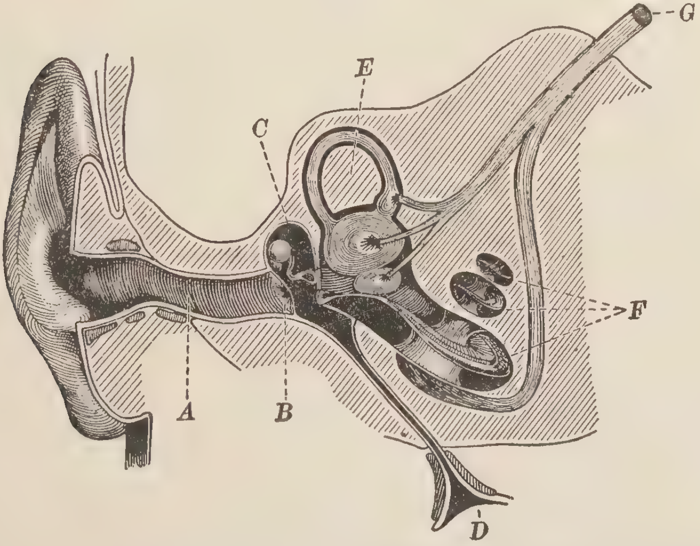

FIG 43.— Diagram of the ear. *A*, the auditory canal, leading to the tympanic membrane *B*; *C*, cavity of the tympanum, communicating by the Eustachian tube with the pharynx *D*; *E*, semi-circular canals; *F*, cochlea; *G*, auditory nerve.

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[1] Adapted from *The Human Mechanism*, pp. 255–57. (Revised edition.) Boston: Ginn & Co., 1918.

rapid the vibrations, the higher is the pitch of the note: and the greater their amplitude, the louder the sound.

The ear is an organ specially adapted to receive these vibrations of air and to transform them into nervous impulses. It is subdivided by anatomists into the outer ear, the middle ear, and the inner ear.

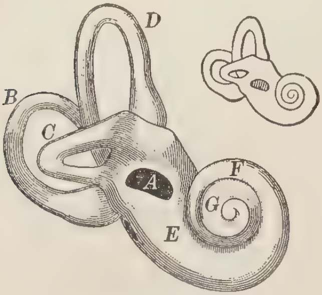

Fig. 44.—The bony labyrinth, its actual size being shown in the smaller figure. *B*, *C*, *D*, the semicircular canals; *A*, the oval window, by means of which the vibrations of the stirrup bone are transmitted to the cochlea; *E*, *F*, *G*, the whorls of the cochlea. Cf. Fig. 43, 235.

The outer ear.—The outer ear consists of the expanded *pinna* (or that part which we commonly call "the ear") and a tube along which the vibrations of sound pass inward to the *tympanic membrane*, or drum. Glands along this canal secrete wax which guards the approach to the drum.

The middle ear; the Eustachian tube.—The tympanic membrane separates the outer from the middle ear, or *tympanum*, a small cavity lying in the temporal bone of the skull and communicating with the throat or pharynx by means of the Eustachian tube. The air which it contains is consequently under the same pressure as that of the atmosphere without, and the tympanic membrane is not normally bulged inward or outward by inequality of pressure on its two sides. The opening of the Eustachian tube into the pharynx is, however, closed except when one swallows, and hence swallowing often relieves the drum from undue pressure of air in the middle ear.

Passing directly across the tympanum, from the drum on its outer side to the cochlea on its inner side, is a chain of three very small bones, the *ear ossicles* (hammer, anvil, and stirrup). These bones are bound together and attached to the walls of the tympanum by ligaments, and are so arranged that when sound waves set the tympanic membrane in vibration this motion is transmitted by the ossicles to a portion of the inner ear known as the *cochlea*.

The inner ear.—The structures of the inner ear lie in the temporal bone, on the side of the tympanum opposite the drum. They consist of a system of small bony spaces and tubes, the *bony labyrinth*, within which lies a corresponding *membranous labyrinth*. Forming part of the lining of the membranous labyrinth are very sensitive cells, and between these cells are the endings of the nerve fibers which connect the ear with the brain. The cells of the inner ear are sensitive to the vibrations which have been transmitted across the tympanum by the ossicles, just as the retina is sensitive to light; and as the retina is the origin of the fibers of the optic nerve, so the inner ear is the origin of those of the auditory nerve.

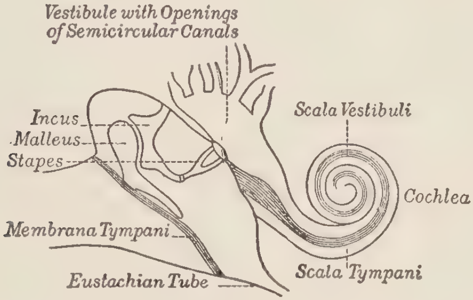

FIG. 45.—Diagrammatic representation of the membranous labyrinth of the cochlea in relation to the structures shown in Figs. 43 and 44. The *scala vestibuli* and *scala tympani* are the two portions of the bony cochlea which inclose the membranous cochlea.

B. The Limits of Hearing[1]

BY WILLIAM H. HOWELL

The rates of vibration that can be perceived by the ear as musical tones lie between fairly well-defined limits, although in this organ, as in the case of the eye, there are individual variations,—variations, indeed, which are more marked in the case of the ear, since its range of appreciation is larger. The lowest rate of vibration that can cause a musical sensation is usually placed at 24 to 30 per second, although some ears can still respond to an octave lower—about 16 per second. To most ears vibrations below 16 per second are felt, if perceived at all, as single pulses that stimulate the sensory nerves of the tympanic membrane itself, giving pressure sensations rather than auditory sensations. It may happen, however, that vibrations too slow to be perceived by the ear as an auditory sensation will give overtones of a higher pitch and of sufficient strength to be recognized. The high limit of audibility, on the other hand, is usually placed at 40,000 double vibrations per second, although the various estimates published vary so widely that in this respect there must be great individual differences. The shrill notes of insects are said to be inaudible to some ears. König, making use of Kundt's method of light powders, succeeded in tuning a series of forks to an estimated rate of 90,000 double vibrations per second. It was found that those between c_7 and c_9 (8192 to 32,768) were generally audible, while the c_{10} (65,536) was inaudible. The limit, therefore, lay between c_9 and c_{10}. Notes near this high limit are not, however, usable in ordinary music; the sensations produced have a disagreeable, if not actually painful, shrillness. The range of vibrations employed in music is illustrated by the seven octaves of the piano, the notes varying from the lowest c of 32 vibrations to c_6 of 4096 vibrations.

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[1] Taken from *A Text-Book of Physiology* (7th ed.), pp. 402–3. Philadelphia: W. P. Saunders Co., 1918.

C. Tonal Gaps and Tonal Islands[1]

BY CARL EMIL SEASHORE

Nature of gaps and islands.—The pitch discrimination of a student was measured at the level of a′, 435 d.v., in the laboratory and she proved quite helpless, being unable to detect differences of a half tone or even a whole tone at that level. As she thought herself capable of appreciating music, she was asked to return and be tested for other ranges, and it was found that she had exceedingly fine sensitiveness to pitch except for about ninety vibrations about a′. She seemed insensitive to pitch differences, even by the keys of the piano, for a′ and a′ ♭; although she heard the tones, she could not distinguish one from the other.

Examples.—We speak of a tonal gap when there is a defect in tonal hearing which is due to the loss of functioning power of certain segments of the harp structure in the ear. When the range of hearing is reduced at either or both ends to a remnant as small as two octaves, we speak of the remnant as a tonal island. We can picture this to ourselves concretely if we think of the bank of strings in a piano as exposed and a child throwing things in upon them—a marble, a building block, a ball, or even a large box or a pillow. If we strike the keys affected, they will have lost their power to respond in the natural way. Let us carry this analogy into our interpretation of tonal islands and tonal gaps.

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[1] Adapted from *The Psychology of Musical Talent*, pp. 83–86. Boston: Silver, Burdett & Co., 1919.

"Patches of hearing."—In an institution for deaf-mutes were found eighteen cases of tonal islands and seven cases of tonal gaps. Deaf-mutes often have what is called a patch of hearing, usually in the region of high notes. A point to be emphasized is that loss of hearing, when due to injury in the inner ear, may occur independently at any pitch level.

Effect on speech and music.—In modern instruction of the deaf, this "patch" is taken advantage of by teaching them to make use of the range of hearing they have. If a person has an island running from b′ to g″, he can learn to hear ordinary speech well, because the most salient characteristics of speech sounds fall within that range; but varied or rich musical tones do not sound to him as they do to a person with normal range, because the high overtones are lost. Ordinary cases of persons "hard of hearing," when analyzed, prove to begin with the loss of certain speech sounds, such as the sibilants, s, z, sh. On the basis of exact analysis of sounds lost, one can diagnose to some degree the exact pitch level of the lesion in the inner ear. The same can be done for the musical sounds.

Limits not always abrupt.—Gaps and islands should not be thought of as abrupt breaks, but should be considered in most cases in terms of the degree of loss of hearing as was illustrated in the case of throwing objects upon the piano strings. Some strings might be entirely broken; others might simply be damped.

Frequency.—We have no satisfactory statistics to indicate to what extent tonal gaps occur in so-called normal hearing. A very careful examination of the tonal range of fifty-five university students by Vance revealed no case of complete gap for any one, but demonstrated one case of a relative gap in the region 60–90 d.v., in which the pitch discrimination rose suddenly at 90 d.v. from less than 1 to about 8 d.v. This seemed to affect pitch only, as there was no loss in intensity or richness of the tones in that gap. The subject was no more aware of this defect through hearing than the color-blind can perceive his color blindness.

Some factors involved.—The whole problem of how these gaps occur in one ear and not in the other, and of how the good ear "covers up" the defect in the other ear remains to be investigated. We shall probably find that gaps in one ear are common, but unless the other ear is similarly affected the defect will not be noticed. The accurate knowledge of these conditions involves measurement of, first, sensitiveness to tones or acuity of hearing; second, the pitch discrimination; and, third, the intensity discrimination for each and every level of pitch within the tonal range.

EXERCISES

1. Practice until you can draw from memory the diagrams of the ear shown in Figures 38 and 39.
2. Why does a rapid descent in an elevator cause a sensation of pressure in the ear?
3. Do air vibrations affect the sensitive cells of the ear directly? Justify your answer.

2. MUSICAL AND NON-MUSICAL SOUNDS[1]

BY SEDLEY TAYLOR

Sounds are either *musical* or *non-musical*. The vast majority of those ordinarily heard—the roaring of the wind, the din of traffic in a crowded thoroughfare—belong to the second class. Musical sounds are, for the most part, to be heard only from instruments constructed to produce them. The difference between the sensations caused in our ears by these two classes of sounds is extremely well marked, and its nature admits of easy analysis. Let a note be struck and held down on the harmonium, or on any instrument capable of producing a sustained tone. However attentively we may listen, we perceive no change or variation in the sound heard. A perfectly continuous and uniform sensation is experienced as long as the note is held down. If instead of the harmonium we employ the pianoforte, where the sound is loudest directly after the moment of percussion, and then gradually dies away, diminution of loudness is the only change which occurs.

In the case of non-musical sounds variations of a different kind can be easily detected. In the howling of the wind the sound rises to a considerable degree of shrillness, then falls, then rises again, and so on. On parts of the coast where a shingly beach of considerable extent slopes down to the sea, a sound is heard in stormy weather which varies from the deep thundering roar of the great breakers, to the shrill tearing scream of the shingle dragged along by the retreating surf. Similar variations may be noticed in sounds of small intensity such as the rustling of leaves, the chirping of insects, and the like. The difference, then, between musical and non-musical sounds seems to lie in this, that the former are constant, while the latter are continually varying. The human voice can produce sounds of both classes. In singing a sustained note it remains quite steady, neither rising nor falling. Its conversational tone, on the other hand, is perpetually varying in height even within a single syllable; if it ceases so to vary, it assumes a musical character, witness the epithet "sing-song" then commonly applied to it.

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[1] Taken by permission from *Sound and Music* (3d ed.), pp. 49–51. New York: Macmillan, 1896. Copyrighted. All rights reserved.

We may then define a musical sound as a *steady* sound, a non-musical sound as an *unsteady* sound. It is true we may often be puzzled to say whether a particular sound is musical or not: this arises, however, from no defect in our definition, but from the fact that such sounds consist of two elements, musical and non-musical, of which the latter may be the more powerful, and therefore absorb our attention until it is specially directed to the former. For instance, a beginner on the violin often produces a sound in which the irregular scratching of the bow predominates over the regular tone of the string. In bad flute-playing an unsteady hissing sound accompanies the naturally sweet tone of the instrument, and may easily surpass it in intensity. In the tones of the more imperfect musical instruments, such as drums and cymbals, the non-musical element is very prominent, while in such sounds as the hammering of metals, or the roar of a water-fall, we may be able to recognize only a *trace* of the musical element, all but extinguished by its boisterous companion.

EXERCISE

1. Consider a number of familiar noises. Try to classify them. Is your classification based upon their noise characteristics or upon the musical or tonal elements in the noises, i.e., according to pitch?

3. CHARACTERISTICS OF MUSICAL SOUNDS

Pitch, Loudness, and Character or Quality[1]

BY WILLIAM POLE

There are three varieties in the character of the original vibrations of an elastic sounding body, and these correspond to three analogous variations in the constitution of the air-waves which transmit the sound to the ear. These are—

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[1] Adapted from *The Philosophy of Music* (4th ed.), pp. 28–39. (Revised.) London: Kegan Paul, Trench, Trübner & Co., 1895.

I. The vibrations may vary in *rapidity;*—corresponding to variations in *length* of the transmitting air-wave.

II. The vibrations may vary in *amplitude* or extent;—corresponding to variations in *intensity* of the transmitting air-wave.

III. The vibrations may vary in *form;*—corresponding to variations in form of the transmitting air-wave.

Now these three variations have a direct practical significance, inasmuch as they correspond, respectively, to three practical properties of musical sounds, which are familiar enough to every one accustomed to music. These are—

I. The *pitch* of the sound.
II. The *strength* of the sound.
III. The *character* of the sound.

Each of them is subject to a wide variability, and each is directly related to the corresponding variable property of the vibrations of the sounding body, and of the transmitting air-wave.

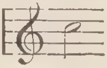
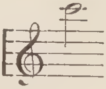
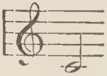
It will be our business, in this chapter, to investigate these relations in regard to each property.

THE PITCH OF MUSICAL SOUNDS

The word *pitch*, in its general sense, refers to the position of any sound in the musical scale of acuteness and gravity. The distinction between what are called "high" and "low" notes is sensible to everybody: each note of a pianoforte is "higher" in pitch than its left-hand neighbour, and "lower" than its right-hand one. And the difference in pitch may be much less in degree than this interval, and still be very evident; as, for example, when we speak of an instrument being a little "too sharp," or of a vocalist singing a little "too flat," which are only common expressions to signify small variations of pitch above or below some imaginary standard.

Now the pitch of a musical sound is determined by the *rapidity* with which the vibrations of the sounding body succeed each other. The quicker the succession of the vibrations, the *higher* is the pitch of the note; the slower the succession of the vibrations, the *lower* is the pitch.

It follows from this, that every musical note that we can form any conception of has a certain rapidity of vibration peculiar to itself; and hence the *number of vibrations* per second, or, as it may be called for brevity, the *Vibration Number*, becomes an accurate definition of the *pitch* of any sound.

Thus, for example, 512 vibrations per second will produce a note that may be represented by the musical sign  while 1024 vibrations per second will produce the note  and 256 vibrations per second will produce the note 

ON THE STRENGTH OF MUSICAL SOUNDS

The second property attributed to musical sounds is their strength, or their degree of loudness or softness. The variations between sounds in this respect are familiar to every one; and as the cause of these variations is very simple, we may dismiss this head very briefly.

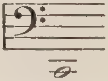
The degree of loudness of sound depends simply on the *amplitude* or extent of the vibrations, and the corresponding *intensity* of the disturbance of the air in the transmitting wave. If a pianoforte string, for example, is struck forcibly, it will be more deflected from a straight line, or will make larger vibrations, than when it is touched gently. These larger vibrations will communicate greater intensity of motion, in compression and extension, to the particles of the air, and will thus cause an impression of greater force to be made on the nerves of the ear, which is what is meant by a louder sound.

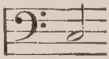
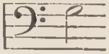
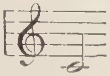
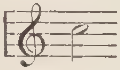
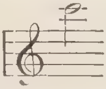
ON THE CHARACTER OF MUSICAL SOUNDS

The third property of musical sounds requires more lengthy notice, as its explanation introduces us to some physical elements which we shall find very important in the philosophical theory of music. It is the *quality* or *character* of the tone produced. A violin, for example, gives a tone of different quality from that of a clarionet, an oboe, a flute, or a trumpet. We have no good English term to express this property; the French use the word *timbre;* but this is not so expressive as the German *Klangfarbe*, a word compounded of *Klang*, a musical sound or tone, and *Farbe*, colour. We must, however, be content with the homely expressions: quality, or *character* of tone.

The varieties of character of tone that may be obtained are almost infinite. We not only possess an immense number of musical instruments and means of producing musical sounds, all of which have their individual qualities of tone, but even on the same instrument the same note may often be given distinct varieties of character, independent of the mere loudness or softness. And that these varieties are real objective physical differences, and not merely ideal, is proved by the facility with which an educated ear can identify and distinguish them, even sometimes to the minutest shades of difference. The stringed tribe of instruments, and still more the human voice, furnish ample examples of this. The tone of a particular violin, or of a particular violin player, can be identified by a connoisseur among a hundred, and we all know that the varieties of character of the human voice, even in the same register, are almost as diversified and as easily recognised by the ear as the varieties of physiognomy are by the eye. And even in the same voice, the numerous varieties of vowel sounds producible, are, when examined carefully, chiefly varieties in character of tone.

The problem is, having given two musical sounds, of the same pitch and the same loudness, but of different character, to discover what is the physical cause of this difference? We know that the velocity and the amplitude of the vibrations are alike in the two cases, and therefore the cause must be sought in some other element of the sound-wave. The explanation, which is somewhat complicated, will be found in the following considerations.

There is a certain phenomenon very familiar to players on some kinds of musical instruments, namely, the production of what are called *Natural Harmonics*. Suppose, for example, a certain source of musical sound, such as the fourth string of a violoncello, or the column of air in the tube of a French horn, is set vibrating at the rate of 64 per second, so as to produce the note 

By certain means well known, it is easy to alter the mode of vibration, dividing the string or column of air into two parts, each of which will vibrate at double the former rate, viz., 128 vibrations. which will give a note an octave higher than before, namely,  This is called a *natural harmonic note* of the fundamental lower C. Again, similarly, the string or column of air may easily be made to divide itself into three equal parts, each of which will make 3×64=192 vibrations per second, and will produce a second natural harmonic, namely, . It may further divide itself into four parts, each vibrating 4×64=256, and giving a third natural harmonic, . The division might be carried further, at pleasure, each harmonic note becoming higher in the scale. For example, the division into eight parts would give 512 vibrations, producing a seventh natural harmonic,  and the division into sixteen parts would produce a fifteenth natural harmonic, 

Now it has been discovered that these natural harmonics play a very important part in the constitution of musical sounds. It seldom happens that a musical sound consists of one simple note; it is generally a *compound*, formed of a fundamental note as a chief, *combined with a certain number of its natural harmonics* sounding along with it. The sounding body has a tendency to divide up into subsidiary parts, which *vibrate independently*, each producing the natural harmonic due to its rate of vibration, and the whole are heard together, forming the compound sound.

In such a sound, the natural harmonics above the fundamental have been called by Helmholtz *overtones* (Obertöne); and the whole series, including the fundamental, have been called *partial tones* (Parzialtöne), from the fact of the compound sound being made up of them. The latter term gives the most convenient numbering; but the former one is the most expressive, as distinguishing the subsidiary harmonics from the fundamental sound.

EXERCISES

1. Which is the greater pitch difference—that between a tone the vibration rate of which is 100 a second and a tone of 101 vibrations a second, or that between a tone of 200 vibrations and a tone of 201 vibrations? Why?
2. What factors may furnish a basis for distinguishing between the voices of different people?

4. COMBINATION TONES

A. Types of Combination Tones[1]

BY ALEX. WOOD

When it is remembered that almost all musical notes carry with them a number of partial tones, some idea of the complexity of the sensation which is produced when two notes are sounded together is borne in upon the mind. Yet this view of the complexity falls far short of the reality. We have so far left entirely out of account a series of tones known as Combination Tones which undoubtedly play some part in our sensations. These tones were first discovered by the organist Sorge about 1745 but afterwards became known through the Italian violinist Tartini and were called Tartini's tones. They are produced when two pure tones are strongly sounded together. The most important type, the one discovered by Sorge and Tartini, is known as the Differential Tone from the fact that its frequency is equal to the difference of frequencies of the two generating notes. There is also a Summational Tone, whose frequency is the sum of the frequencies of the two generators. This tone is much fainter than the Differential Tone and was not discovered till much later. Both these tones are known as First Order Combination Tones to distinguish them from those of higher orders. These latter are given by one of the generators with one of the Combination Tones. Thus the Second Order Tones are generated by one of the generators and one of the First Order Tones, and so on.

B. Beats[2]

BY ALEX. WOOD

. . . . If we take two tuning-forks of the same pitch and load the prongs of one with a little wax so as to diminish its frequency and lower its pitch, we shall find that if they are made to sound together we get very marked alternate swells and lulls of the sound. The phenomenon is known as beating. Suppose that the loaded fork now makes one vibration less in each second than the unloaded one, and suppose further that we start our consideration of the phenomenon when they are vibrating in the same phase—i.e., they send out their compressions together and their rarefactions together; these will travel to the ear and simultaneously produce their effects on the membrane which will thus have imparted to it a double amplitude of vibration—assuming the amplitudes of the two forks to be equal. Thus the ear will hear a loud sound. But one of the forks is gradually gaining on the other and after half a second it will have gained half a vibration so that now when one fork sends out a compression the other sends out a rarefaction at the same instant and vice versa. Consequently a compression from one fork reaches the ear simultaneously with a rarefaction from the other, the two annul one another, the membrane of the ear does not move, and no sound is heard, although both forks are still sounding strongly. The fork of greater frequency still continues to gain and at the end of the second has gained a complete vibration and once more the conditions existing at the beginning of the second are repeated. Thus we have a succession of beats occurring regularly once a second. In order to have periods of absolute silence it is necessary that the two amplitudes should be the same—a condition difficult to ensure—but if the amplitudes are even nearly the same the beating will be very marked. Beats have several important applications in music. They enable us to achieve very great accuracy in tuning two notes to unison. If the two notes are at all close in pitch beats will be heard. One of the notes is then slightly altered. If the beating is rendered slower, unison is being approached and the note is further altered in the same direction until the beating finally disappears. From what has been said it will be obvious that the number of beats per second given by two notes is equal to the number of whole vibrations which the one will gain on the other in one second, and is therefore equal to the difference of frequencies.

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[1] Taken from *The Physical Basis of Music*, pp. 104–5. Cambridge: University Press, 1913.

[2] Taken from *op. cit.*, pp. 42–43.

EXERCISE

1. Difference tones are sometimes explained as due to beats. What justification can you see for this explanation?

5. MUSICAL INTERVALS AND TEMPERAMENT[1]

BY REV. J. A. ZAHM

The sounds with which the acoustician deals range in frequency from sixteen to nearly fifty thousand vibrations per second. Of these, only a comparatively small number are employed in music, and they must always bear to each other certain definite relations of pitch.

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[1] Taken from *Sound and Music*, pp. 387–90. Chicago: A. C. McClurg & Co., 1900.

The ratios of frequencies which characterize such sounds are called *intervals*. Thus, two notes whose frequencies are as 2:1 constitute the interval of an octave. Two notes whose vibration-numbers are as 3:2 give the interval of a fifth. These intervals are independent of the position that the notes may occupy on the scale. Provided the ratio of their frequencies remains the same, the interval retains the same name, whether the notes are in one part of the scale or in another.

The *gamut*, or *diatonic scale*, embraces a series of eight notes, the first and last of which have the same names, and are separated from one another by the interval of an octave. The notes of the gamut have been designated by the letters—

$$C, D, E, F, G, A, B, C_2.$$

Considering the frequency of C as unity, the frequencies of the notes of the scale, including the *tonic*, or first note, will be proportional to the numbers—

$$1, \quad \frac{9}{8}, \quad \frac{5}{4}, \quad \frac{4}{3}, \quad \frac{3}{2}, \quad \frac{5}{3}, \quad \frac{15}{8}, \quad 2.$$

Dividing each of these notes by that which precedes it, we obtain the intervals between the successive notes of the scale. The intervals of the major scale are as follows:—

$$C, D, E, F, G, A, B, C_2,$$

$$\frac{9}{8}, \quad \frac{10}{9}, \quad \frac{16}{15}, \quad \frac{9}{8}, \quad \frac{10}{9}, \quad \frac{9}{8}, \quad \frac{16}{15}.$$

The consecutive intervals from C to C_2 are called *a second, a major third, a fourth, a fifth, a major sixth, a major seventh*, and *an octave* respectively. C, from which the intervals are reckoned, is called the *tonic*, or *key-note*. Musicians call the fifth note above the key-note the *dominant*, and the fifth note below, the *sub-dominant*. When the key-note is C, the dominant is G, and the sub-dominant is F in the octave below C.[1]

In the foregoing scale, as will be observed, there are only three different intervals, viz., $\frac{9}{8}$, $\frac{10}{9}$, and $\frac{16}{15}$. The first, $\frac{9}{8}$, is called a *major tone;* the second, $\frac{10}{9}$, is named a *minor tone;* and the last is known as a *major* or *diatonic semitone*. The last interval, although called a semitone, is a little more than the half of a major tone. Adding together two semitones,—which is done by multiplying the frequency-ratio, $\frac{16}{15}$, by itself,—we obtain a number which is slightly greater than $\frac{9}{8}$:—$\frac{16}{15} \times \frac{16}{15} = \frac{256}{225}$; $\frac{256}{225} : \frac{9}{8} :: 2048 : 2025$. Two semitones are therefore greater than a major tone in the ratio of 2048 : 2025. Subtracting a major semitone from a minor tone gives a *minor* or *chromatic semitone*, $\frac{10}{9} + \frac{16}{15} = \frac{25}{24}$. This interval is the smallest usually employed in music. A less interval, and one of considerable importance in theoretical music, is a *comma*. It is yielded by subtracting a minor from a major tone, $\frac{9}{8} + \frac{10}{9} = \frac{81}{80}$. Tones, like major and minor tones, that differ from each other by only a comma, are considered in music to have the same value. The same may be said of major and minor semitones. The ratio between these two being less than a comma,—$\frac{16}{15} + \frac{25}{24} = \frac{128}{125}$,—they are regarded as semitones of equal value.

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[1] When necessary, the subdominant is transposed into the octave of the tonic.

The various notes of the diatonic scale are, with respect to their frequencies, related to one another as follows:—

Tonic		Second		Major Third		Fourth		Fifth		Major Sixth		Major Seventh		Octave
C_3		D		E		F		G		A		B		C_4
256	:	288	:	320	:	341.3	:	384	:	426.6	:	480	:	512
1	:	$\frac{9}{8}$	:	$\frac{5}{4}$	:	$\frac{4}{3}$	:	$\frac{3}{2}$	:	$\frac{5}{3}$	:	$\frac{15}{8}$	:	2

Using the smallest whole numbers expressing these ratios, we have—

24 : 27 : 30 : 32 : 36 : 40 : 45 : 48

All the intervals here given, with the exception of the second and the major seventh, are what are known as *consonant* intervals. The second and the seventh form intervals that are called *dissonant*. The ratios corresponding to the former are expressed by small whole numbers, and the more consonant the interval, the smaller the whole number expressing the ratio. Hence, after unison, the most consonant interval is the octave. After the octave come in succession the fifth, the major third, and the major sixth.

Dissonant intervals, on the contrary, are characterized by ratios composed of large numbers, and the amount of dissonance to which any two sounds may give rise may, at least in the middle portion of the musical scale, be determined by the ratio of their vibration-frequencies. Thus the interval of a major tone, $\frac{9}{8}$, is, in the lower portions of the musical scale, markedly dissonant. A diatonic or a chromatic semitone, whose vibration ratios are respectively $\frac{16}{15}$ and $\frac{25}{24}$, are, in similar portions of the scale, far more dissonant. The intervals, $\frac{2}{1}$, $\frac{3}{2}$, $\frac{4}{3}$, are called respectively the perfect octave, the perfect fifth, and the perfect fourth, to distinguish them from certain diminished or augmented intervals of the same name. They are said to form *perfect consonances*, in contradistinction to the intervals, $\frac{5}{4}$, $\frac{5}{3}$, and the minor third, $\frac{6}{5}$, and the minor sixth, $\frac{8}{5}$, which are denominated *imperfect consonances*. The minor third is obtained by subtracting a chromatic semitone from a major third: $\frac{5}{4} \times \frac{24}{25} = \frac{6}{5}$. Similarly, a minor sixth is equal to a major sixth less a chromatic semitone, $\frac{5}{3} \times \frac{24}{25} = \frac{8}{5}$.

EXERCISE

1. Why do musical scales contain only certain tones?

6. THEORIES OF CONSONANCE AND DISSONANCE

A. The Theories of Stumpf and of Helmholtz[1]

BY BURTIS BURR BREESE

Consonance and *dissonance* have been explained in several ways. According to Stumpf, consonance is due to the fusion of tones. Those tones that blend smoothly and fuse with one another more or less completely, so that the resulting sensory experience resembles a single tone sensation, are consonant; while those tones that refuse to blend or fuse together into a single experience and remain apart, are dissonant. Unity of tonal impression is, therefore, according to Stumpf, the measure of consonance. Helmholtz considers consonance the absence, and dissonance the presence of beats in simultaneously sounding tones. In considering this theory, we must remember that most single tones are compounds, made up of fundamentals and overtones. The overtones of one note may coincide or may beat with the overtones of another note. The degree of consonance of tones goes hand in hand with the amount of coincidence of their overtones. In the octave, where there is perfect consonance, the overtones coincide and, therefore, there is no beating. In the minor sixth (c—♭a=5:8), just on the border-line between consonance and dissonance, the lower overtones (the second of c and the first of ♭a) beat audibly with each other. In more dissonant intervals the overtones beat still more markedly. The roughness of dissonant intervals, produced by the beats, is unpleasant, just as intermittent sensations of any kind are unpleasant.

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[1] Taken from *Psychology*, pp. 164–65. New York: Charles Scribner's Sons. Copyrighted, 1917.

In regard to successive tones, Helmholtz has suggested that their relation depends upon the similarity or dissimilarity of their overtones. A tone is most like its octave tone because the overtones of the two are coincident. In passing from the one to the other a large part of the end-organs active for the first tone are stimulated again by the second. A tone and its second or its seventh show little or no kinship, because the overtones of the one are different from those of the other. In passing from the one to the other of such tones, different end-organs are stimulated. Therefore the tones have nothing in common.

B. A Genetic Theory of Consonance[1]

BY HENRY THOMAS MOORE

The phenomenon of consonance, if the theory here advanced is right, is a special case of the adjustment of the inner to the outer relations. The nervous system, by a form of activity that tends with each repetition to become more simple and economical, gradually affects the synthesis of more complex physical relations. The affected aspect of the various stages of this process becomes more explicable when we consider that consciousness is most vividly present where new adjustments are being made Where a synthesis has been accomplished so often as to be affected with ease, as in the case of the fifth, the output of consciousness is low as compared with that involved in synthesizing the third, where the accomplishment is relatively difficult. Now according to Professor Fite, whose view I accept, the whole question of pleasure-pain is to be referred to the same conflicts which occasion consciousness. To quote from him: "Not only is conflict a condition of consciousness, but it is especially a condition of pleasure-pain. . . . . Pleasure is succeeding, pain is failing in the process of resolving a conflict." Using as an illustration a game of tennis, or of chess, he says: "All the feeling lies between two points—between that at which your opponent becomes strong enough to offer appreciable resistance and that at which he becomes so strong that any effort on your part is futile. If your opponent is too weak, struggle is unnecessary; if he is too strong, struggle is useless." In another passage he says to the same effect,—"There is certainly a more intense pleasure in removing a stubborn obstacle than a pliant one. Pleasure depends not merely upon the prosperity of our undertakings, but upon the size of them, as estimated by the difficulties presented." This last sentence presents, I think, exactly the point of view which we must carry to the consideration of the varying pleasurability of various intervals. It is thus that we can understand why different periods of history, different peoples of the same period of history, and the same individual at different periods of his own development can give such different accounts of the same interval. We may say that the fifth was the most pleasurable of all intervals for the ninth century hearer because, in the conflict which his synthesizing mind waged against the complexity of physical relations, he was just able to succeed with the 2:3 ratio. The third, 4:5, was slightly too difficult, but not so much as to discourage further hearing, especially if it could be immediately followed by a fifth. With a further advance, due to repeated hearing, the fifth becomes a relatively uninteresting affair, whereas the third, which can just be unified, acquires a tremendous vogue. Hence the amazing fondness for thirds at the time of Monteverde, hence the high value of the third for the young child of today, hence the rapid decline of the third when heard with great frequency by the adult to-day. The minor seventh, we may suppose, was almost discouragingly complex for the hearer in the tenth century,—as for Valentine's nine-year-old girls who gave it a value of −44 as compared with +52 for the major third. But with more and more frequent hearing it has been attacked with nearer success. Its rapid gain in my experiments is most clearly understood if we consider the 5:9 ratio as a tonal adjustment not quite completely successful. That it will later rank among the consonances we can scarcely doubt, if past successes are any index to the future. When it does become so, it will be the most pleasurable of all intervals, since its unification will make more demands on the mind than that of any of the other consonances. Exactly the same is to be said for the major seventh. At first it is disheartening in the opposition it offers to synthesizing activity, but the change that takes place with repeated hearing is, as a rule, definitely positive. Certainly it will take thousands, perhaps hundreds of thousands, of hearings to bring it about that its impression will be distinctly less dissonant than at present, but this is no reason for assuming that it will mark any exception to the law of consonance evolution.

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[1] Taken from "The Genetic Aspect of Consonance and Dissonance," *Psychological Review, Monograph Supplements*, XVII (1914), 62–64.

EXERCISE

1. How can you reconcile the theories of Helmholtz, Stumpf, and Moore?

7. THE ELEMENTS OF MELODY[1]

BY WALTER VAN DYKE BINGHAM

Let the reader ask himself in what way his experience of a melody differs from his experience of a mere succession of musical sounds of varying pitch. Possibly he will reply that the group of sounds that he calls a melody is more pleasing. But this agreeableness he will admit is not the essential character. One may, for example, upon hearing a flageolet of obnoxious tone quality find the whole experience disagreeable and yet recognize that what he is hearing is a melody; or on the other hand one may take delight in a perfectly random series of sounds drawn from a beautifully voiced instrument. Something other than the pleasurable affective aspect of the total experience must be present to differentiate the melody from the non-melodic succession of pitches.

Upon further comparison of the two kinds of experience the observer will notice that the sounds of the melody seem to belong together, to cohere, and to stand in such a relationship each to the others that the entire series is felt to be a unity. The tones of the non-melody, by contrast, are felt to be unrelated: they do not "hang together" as it were. Or, even if one discovers that some of the tones of the non-melodic group exhibit a close connection with some of the others, the group as a whole is not a unity: it is felt to lack consistency or internal coherence, or continuity, or completeness.

An example will make more obvious this contrast between the melody and the non-melody. I played to a group of moderately musical observers the following simple succession of musical sounds: *c′ e′ g′ e′ f′ d′ c′*. The tempo was slow, the duration of the tones uniform. I then played a second series beginning on the same tone and ending on the same tone, and employing the same five degrees of pitch as the first but in a different order: *c′ f′ d′ g′ e′ f′ c′*. The hearers reported that in the first group the sounds seemed to follow each other naturally, coherently, and in a way, inevitably, and with the last sound the series seemed to come to a definite close. Each element articulated with the others and the group as a whole was felt to be a unity. In other words, it was judged to be a melody. But with the second series of tones the hearers failed to discover this naturalness or inevitableness about the order of the sounds. The pitch, they said, wandered rather incoherently and disconnectedly here and there. Moreover when the last sound was heard it failed to bring the feeling of completeness, of finality, which characterized the close of the former series. This second succession of tones was judged by these observers to be no melody.

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[1] Taken from "Studies in Melody," *Psychological Review, Monograph Supplements*, XII (1910), 3–6.

Our definition of a melody places stress upon the experience of unity; but it does not prejudge the question as to whether this necessitates the subordination of all the elements to one dominating "monarch element." Neither does it imply that the experience of definite "melodic relationships" (in the technical sense of the term) is the *sine qua non*. A melody we shall define as *a succession of musical sounds which is felt to constitute an esthetic unity*, a unity toward the establishment of which the *pitch* relations of the successive tones contribute.

The melody problem, then, is the problem of explaining how a series of discrete tonal stimuli can arouse this feeling of unity.

As a matter of fact any actual melody such as a gamin whistles on the street or a Pawnee Indian sings to the dawn, gains its unity, its coherence, its wholeness, through the combined operation of many factors. The factors of intensity and duration, for example, are coördinate with pitch in the determination of the total psychosis: tempo, rhythm, dynamic structure share in determining what the melody shall be. A brief analysis of these factors will bring into prominence the particular phases of the melody problem with which these studies are concerned.

It is to be remembered that musical sounds can vary one from another in only four ways: in duration, intensity, clang-color (i.e., tone-quality or timbre) and pitch. But each of these four aspects or attributes of the constituent tones affects in a two-fold manner the nature of the melody. The total effect is what it is, partly because of the *relative* duration, intensity, pitch and color of the separate sounds employed, and partly because of the *actual* pitch, intensity, duration and color. The "actual duration" factor, for instance, is the tempo The relative duration of all the sounds remaining constant, the nature of the melody may be entirely altered merely by changing the speed, i.e., the actual duration of the sounds. A familiar melody played in an unusual tempo may be hardly recognizable, and if the change of time is carried beyond certain limits in either direction the melody is utterly destroyed,—it becomes a confusion of noises or a broken succession of sounds without significance or interest.

Similarly, the actual or "absolute" pitch of a melody enters in to make it what it is. The low rumbling melody with which Grieg begins the "Dance of the Trolls" in the first Peer Gynt suite is almost a totally different thing when played in the twice-accented octave, instead of the three octaves lower.

The difference which the actual clang-color makes is of course at the basis of artistic orchestration of melodies and of organ-registration. When a theme given out by the oboe is repeated by the violins we say it is the same melody, and yet it is not wholly the same.

Fourthly, the dynamic factor, the actual loudness or softness of the melody as a whole, remains to be mentioned as one of the contributors to the nature of the melody.

EXERCISE

1. How can you explain the fact that some melodies seem to be more pleasing the more we hear them, while others soon become wearisome?

8. THE BASIS OF AUDITORY ANALYSIS

A. The Helmholtz Theory[1]

BY GEORGE TRUMBULL LADD AND ROBERT SESSIONS WOODWORTH

One of the most important facts to bear in mind in framing a theory of the action of the cochlea is the analytic power of the ear. The vibrations which reach the ear from the air, when a chord of several tones, or even when a single tone, is sounded with its accompanying overtones, are highly complex, but a "trained ear" can analyze the complex into the separate tones of which it is composed.

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[1] Taken from *Elements of Physiological Psychology*, pp. 206–7. New York: Charles Scribner's Sons. Copyrighted, 1911.

The "training" occurs, no doubt, in the brain and not in the ear; but the brain could not distinguish the components unless the ear had first broken up the complex vibration into its elements, and sent to the brain an impulse corresponding to each.

A theory which accounts in an elegant manner for this analytic power of the ear, and for its power to respond differently to tones of differing pitch, is the resonance or sympathetic vibration theory of Helmholtz. What is meant by "sympathetic" vibration is illustrated when a piano string, for instance, which is tuned to vibrate at a certain rate, takes up vibrations of this rate from the air, and is itself set in vibration by them. If the dampers are lifted from the strings of a piano, and a particular tone be sung into it, it answers with the same tone; if two or more tones are simultaneously sung into it, it answers with the same combination of tones, the strings tuned to these tones having been set into sympathetic vibration. Helmholtz conceived that the transverse fibres of the basilar membrane might be likened to the strings of a piano, and since they are of different length, might be tuned to tones of different pitch, and vibrate sympathetically, each to its own vibration rate.[1] The vibration of any fibre of the basilar membrane would naturally excite the hair-cells in its immediate neighborhood; different hair-cells would thus be set in vibration for different pitches, and different combinations of them for different combinations of tones; and thus the sense for pitch and the analytic power of the organ would find their explanation.

B. Other Theories[2]

BY MARY WHITON CALKINS

Certain alternatives proposed by contemporary psychologists to the Helmholtz theory should briefly be named. In criticism of the theory it is urged, first, that the basilar membrane fibres are not capable of vibrating so freely as the theory requires; and second, that their variations in length—only 0.04 to 0.49 between the longest and the shortest of the 24,000 fibres—is too slight to permit vibrations ranging from 15 to more than 20,000 per second. In lieu of the

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[1] Shambaugh and Prentiss have advanced a theory that it is not the fibers of the basilar membrane, but the tectorial membrane just above it, which functions as a physical resonator.—EDITORS.

[2] Taken by permission from *A First Book in Psychology*, pp. 316–17. New York: Macmillan Co. Copyrighted, 1910.

Helmholtz hypothesis, and to avoid these difficulties, the following theories, among others, have been advanced:—

(1) The hypothesis of Rutherford (the so-called telephone theory) regards the cochlea merely as a transmitting instrument, and holds that the special characters of a sound sensation have purely cerebral explanation.

(2) The theory of Ewald is based on experiments with elastic membranes, some of them of minute size and of great delicacy. Ewald found that such a membrane vibrates throughout its length at each stimulation and that, examined under a microscope, it presents the picture of a series of waves, visible as "dark, transverse streaks." These sound-pictures, as Ewald calls them, vary, that is, the crests of the waves vary in their interval for each tone; and Ewald supposes that, at these intervals, hair-cells and nerve-fibres are stimulated.

(3) The theory of Max Meyer is not easily stated in abbreviated form. He supposes that successive sound waves, of a given vibration number, travelling up the *scala vestibuli*, press down the basilar membrane, and that pitch is due to the number per second of these downward pressures, and loudness to the extent of basilar membrane, and thus to the number of nerve terminations, excited.

EXERCISES

1. It has been said that no physical strings hold their tautness indefinitely. Since we know that the pitch of a string varies with tautness, what bearing may this have on Helmholtz' theory?
2. Which of the theories of auditory analysis is in accord with and which violate the doctrine of specific energies? See chapter ii.

CHAPTER IX

THE OTHER SENSES

1. TASTE

A. The End-Organs of Taste[1]

BY H. NEWELL MARTIN

The organ of taste is the mucous membrane on the dorsum of the tongue and, in some persons, of the soft palate and fauces.

On the tongue most of the sensory nerves run to papillae; the circumvallate have the richest supply, and on these are peculiar end organs (Fig. 46) known as *taste-buds;* they are oval and embedded in the epidermis covering the side of the papilla. Each consists, externally, of a number of flat cells and, internally, of six or eight so-called *taste-cells.* Taste-buds are also found on some of the other papillae, and it is possible that simpler structures, not yet recognized, and consisting of single taste-cells are widely spread over the tongue, since the sense of taste exists where no taste-buds can be found.

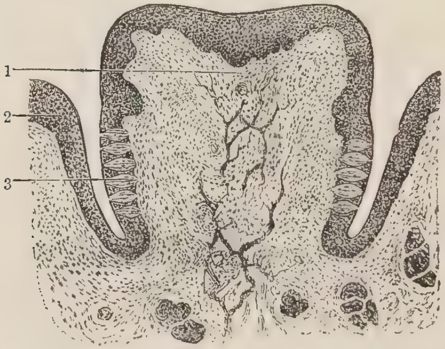

Fig. 46.—Taste buds are shown in the diagram as 3.

In order for substances to be tasted they must be in solution: wipe the tongue dry and put a crystal of sugar on it; no taste will be felt until exuding moisture has dissolved some of the crystal. Excluding the feelings aroused by acid substances, tastes proper may be divided into sweet, bitter, acid, and saline. Although contributing much to the pleasures of life, they are intellectually of small value;

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[1] Adapted from *The Human Body* (10th ed.), pp. 240–41. (Revised by Ernest G. Martin.) New York: Henry Holt & Co., 1919.

the perceptions we attain through them as to qualities of external objects being of little use, except as aiding in the selection of food, and for that purpose they are not safe guides at all times.

B. The Activation of the Taste-Buds[1]

BY RUSSELL BURTON-OPITZ

When food is taken into the mouth, it is subjected to a mechanical as well as chemical reduction, with the result that it is brought into intimate relation with the largest possible number of taste buds. Substances to be tasted must, of course, be in a fluid state. This end is generally attained with the aid of the saliva which not only acts as a solvent, but also tends to carry the particles into the crevices between the base of the tongue and the fauces, and facilitates their entrance into the furrows around the papillae in which the taste buds are situated. Clearly, the movements of the tongue are not essential to taste, but materially facilitate the reduction and distribution of the food. It may be concluded, therefore, that the sensation of taste arises in consequence of a reaction between the sapid substance and the protoplasm of the gustatory cells, through the intervention of their hair processes. It must also be evident that this reaction can only take place if the sapid agent possesses definite chemical properties. It is true, however, that chemically allied bodies need not exhibit identical characteristics in this regard. Thus, sugar, saccharin and lead acetate all give rise to a sweet taste, while the starches do not. In addition, it should also be remembered that sensations of taste may be evoked by substances contained in the blood. Thus, the jaundiced person frequently experiences a bitter taste, while the diabetic perceives sweet. It has also been claimed that sensations of taste may be evoked by electrical means, but not by mechanical or thermal stimuli. Thus, it is usually stated that the anode gives rise to a sour and the cathode to a bitter sensation. This phenomenon has been referred by some experimenters to a direct excitation of the taste buds, while others contend that it arises only in consequence of electrolytic dissociations at the seat of the electrodes. At the present time no facts are at our disposal which could be used to exclude the second view, and hence, we must regard the excitation of the taste buds by inadequate stimuli as not proven.

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[1] Taken from *A Text-Book of Physiology*, pp. 750–51. Philadelphia: W. B. Saunders Co., 1920.

C. The Topography of the Sense of Taste[1]

BY RUSSELL BURTON-OPITZ

While the sensations of taste are very numerous, it is possible to arrange them in four fundamental groups, namely, as sweet, bitter, acid, and salty. Such modalities as burning, astringent, aromatic and oily are composite in their nature and require the simultaneous activation of the olfactory cells as well as of the sense-organs for touch and temperature. Thus, weak acids give an astringent sensation in addition to a distinct taste of sour, while strong acids amplify the primary impression by a burning sensation. A similar amplification of common sensibility is effected by alum and pepper.

Even the fundamental taste sensations may be combined to give a fused or compound effect. Thus, weak solutions of sweet and salty substances may yield a sensation of flatness or alkalinity, and a weak sensation of sweet may be completely neutralized by the addition of a few grains of sodium chloride. Quite similarly, the addition of sugar to lemon juice diminishes the acidity of the latter and gives rise to a mixed sensation in which the components may be clearly recognized.

It is also to be noted that the tongue is not equally sensitive to all four primary tastes. By far the greatest acuity for sweet prevails upon the tip of tongue, while bitter is most clearly perceived upon its posterior aspect in the vicinity of the circumvallate papillae. The acuity for sweet decreases gradually from before backward and that for bitter in the opposite direction. The sour taste is most highly developed in the central fields of the marginal regions of the tongue, and the salty taste in its antero-lateral regions. Peculiarly enough, these different sensibilities may be varied by means of certain drugs. Thus, we find that the application of a solution of cocain to the surface of the tongue first of all diminishes our acuity for the compound impressions, so that acids produce merely a sour taste without any astringent or burning admixture. Next in order follow the fundamental sensations, namely, bitter, sweet, sour and salty. A very similar effect may be produced by chewing the leaves of *gymnema sylvestre*. In this case, the sensations of sweet and bitter are destroyed, while the acid and salty tastes, as well as the general sensibility, are not impaired.

EXERCISE

1. Describe some food substances in respect to (*a*) their taste and (*b*) their other sensory qualities.

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[1] Taken from *op. cit.*, pp. 751–52.

2. SMELL

A. End-Organs, Stimuli, and Qualities[1]

BY H. NEWELL MARTIN

The region of the nostril nearest its outer end possesses the sense of touch: the olfactory organ proper consists of the upper portions of the two nasal cavities, over which the endings of the olfactory nerves are spread and where the mucous membrane has a brownish-yellow color.

Odorous substances, the stimuli of the olfactory apparatus, are always gaseous and frequently act powerfully when present in very small amount. We cannot, however, classify them by the sensations they arouse, or arrange them in series; and smells are but minor sensory factors in our mental life, although very powerful associations of memory are often aroused by odors. We commonly refer them to external objects, since we find that the sensation is intensified by "sniffing" air into the nose, and ceases when the nostrils are closed. Their peripheral localization is, however, imperfect, for we confound many smells with tastes (see below); nor can we well judge of the direction of an odorous body through the olfactory sensations which it arouses.

B. Confusions between Taste and Smell[2]

BY WILLIAM H. HOWELL

The seemingly great variety of our taste sensations is largely due to the fact that we confuse them or combine them with simultaneous odor sensations. Thus, the flavors in fruits and the bouquet of wines are due to odor sensations which we designate ordinarily as tastes, since they are experienced at the time these objects are ingested. If care is taken to shut off the nasal cavities during the act of ingestion even imperfectly, as by holding the nose, the so-called taste disappears in large measure. Very disagreeable tastes are usually, as a matter of fact, due to unpleasant odor sensations. On the other hand, some volatile substances which enter the mouth through the nostrils and stimulate the taste organs are interpreted by us as odors. The odor of chloroform, for instance, is largely due to stimulation of the sweet taste in the tongue.

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[1] Adapted from *The Human Body* (10th ed.), pp. 239–40. (Revised by Ernest G. Martin.) New York: Henry Holt & Co., 1919.

[2] Taken from *A Text-Book of Physiology* (7th ed.), p. 297. (Thoroughly revised.) Philadelphia: W. B. Saunders Co., 1918.

EXERCISE

1. Enumerate some odors that are commonly thought of as taste qualities.

3. THE SKIN OR CUTANEOUS SENSE[1]

BY PERCY GOLDTHWAIT STILES

Nerve-fibers of the skin.—The human skin has been computed to have an area of about 2 square meters. It is thus as large as a rug 3 feet wide and 6 feet long. Afferent fibers in enormous numbers lead from small subdivisions of this large expanse and no point upon it is far removed from nerve-terminals. Sherrington has attractively compared the skin with its nerves to the surface of a pond where many aquatic plants are growing. Their branching filaments are distinct from one another, but often overlapped or entwined. When a stone is thrown into the pond it stirs most decisively the growth on which it directly falls, but other leaves and stems will share somewhat in the disturbance. Perhaps in some respects the skin is even more like a marsh in which the foot sinks, crushing the grasses on which it is set and at the same time pressing down an area much larger than that which it actually covers. It is precisely in this way that a pencil point pressed into the skin stimulates powerfully the nerve-twigs just beneath the selected spot, but extends its effect to others within a certain radius.

The nerve-fibers of the skin take their rise in part from fine ramifications among its deeper cells. Others lead away from special terminal organs of one kind and another. These microscopic end-organs (tactile corpuscles, etc.) have been minutely studied and will be found described in detail in works on histology. It is needless here to discuss the relation of the several types of nerve ending to the several forms of stimulation to which each may respond. We shall assume that only one result can follow the stimulation of a given fiber, whatever the means employed. If we are right in taking this position, we must conclude that the variety of sensations which can be elicited through the skin is made possible by a corresponding number of afferent pathways.

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[1] Adapted from *The Nervous System and Its Conservation* (2d ed.), pp. 75–78. (Revised.) Philadelphia: W.B. Saunders Co., 1917.

We derive from the skin at least four kinds of sensation—pressure, warmth, cold, and pain. As we have accepted, provisionally at least, the "Müllerian principle,"[1] we must believe that a fiber which is once found to give the sensation of pressure when it is stimulated can never give any other sensation. For the impulses, however they may be started on their way, are of an unvarying nature and take always the same direction. On their arrival within the confines of the central nervous system they must produce over and over the same set of effects. The only qualifying statement which should be made is that strong stimuli of any kind may, very probably, initiate impulses which shall penetrate farther than those originated by less intense applications. So, according to one theory, *pain* may be produced by a sufficiently strong excitation of any afferent nerve, its occurrence being the sign of an extension of the brain process beyond the usual field. But the more generally accepted view is that pain is a sensation for which a particular nervous mechanism is requisite and that the nerves concerned can give rise only to painful sensory phenomena.

Experimental study supports the *a priori* deductions in regard to the multiple character of the receptor equipment of the skin. If one applies to the arm a heated rod of glass, one's first impression is that sensations of pressure and temperature—perhaps of pain also—are produced by stimulation of a single spot. But if the trial is made more carefully, employing a slender instrument for the test and avoiding deformation of the skin, one brings to light what is called the "punctiform" distribution of sensibility. By this expression is meant the existence of particular areas of very small size from which particular sensations can be aroused, while others cannot.

It is possible to mark off a chosen region on any part of the surface of the body and to determine within its boundaries the points which respond appropriately to four forms of stimulation by the four kinds of sensation enumerated above. Four sets of points can then be indicated in color, and if the cutaneous map is preserved for a time the points are found to be permanent. They must be situated just over the endings of four distinct though more or less commingled sets of nerve-fibers. It is now easy to see how more than one kind of sensation may seem to be produced when the skin is touched. If the object which makes the contact is rather blunt, it is certain to affect one or more pressure-points, while it will either give or take heat to such an extent as to stimulate neighboring organs which are sensitive to temperature changes. The skin is like a mosaic so finely subdivided that a close examination is necessary to resolve it into its constituent parts.

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[1] See p. 55.—EDITORS.

We must expect that stimulation of a selected ending in the skin by unusual means will give no sensation but the one proper to that fiber. It is, in fact, rather difficult to excite a pressure-point by forms of stimulation other than pressure, but it is not impossible to do so, and the sensory result is reported to be still a sensation of pressure. A better example of perverse excitation is observed when a spot previously found to be affected by cold is touched with a rod which is quite hot. The spot is found to respond with the only sensation which can possibly result from its stimulation, namely, that of cold. So when any area large enough to include both warm and cold spots is brought into contact with something hot, the sensation has a mixed character and may be discovered to contain recognizable elements of warmth and cold. Indeed, the tingle which we call "cold" may be so prominent that for a moment we think that the object has a low instead of a high temperature.

EXERCISE

1. If the qualities of skin sensations are only four in number, i.e., pressure, warmth, cold, and pain, how do we have such experiences as roughness, smoothness, wetness, and tickle?

4. THE MUSCLE SENSE[1]

BY JAMES DUNLOP LICKLEY

The neurons that carry the impulses of the muscle sense towards the cerebro-spinal axis receive their stimuli through the neuro-muscular and neuro-tendinous spindles. Normally, the muscle sensations are always combined with sensations from pressure end-organs in the skin and joints.

Two distinct forms of the muscle sense may be recognised:

1. Sensations resulting from active movements of the muscles. It is these that are more particularly related to the neuro-muscular and neuro-tendinous spindles; they are called into play in judging the force and extent of the movements, and on them are based judgments of weight, resistance, effort, and force generally. In combination

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[1] Taken by permission from *The Nervous System*, p. 121. (New impression.) New York: Longmans, Green & Co., 1919.

with the pressure sensations they provide a stereognostic sense by which the form and solidarity of external objects are ascertained.

2. Sensations of position, evoked when either active or passive movements are carried out. Through these is gained a knowledge of the position of muscles and joints in relation to one another and to the rest of the body. Combined with the other general sensations they provide information regarding the position of the body, or part of the body, in space.

Many of the afferent impulses arising from the muscle spindles are not translated into consciousness, and there is a notable difference in this respect between individuals trained to observe sensations and those untrained. Whether a sensation be aroused or not, however, the ingoing impulses exercise an important influence over the voluntary muscles, and are apparently essential to the co-ordinated action of these, for any particular movement. The sensory neurons for the muscle sense take part in three distinct series of reflex pathways. In one the reflex centre is in the spinal cord; in a second in the cerebellum, and in the third in the sensory-motor cortex around the fissure of Rolando.

EXERCISE

1. There are cases where, because of a condition of the spinal cord, afferent impulses from the muscles of the legs do not reach the brain. What effect would you expect this fact to have upon one's ability to walk? Why?

5. THE SENSE OF EQUILIBRIUM

A[1]

BY H. NEWELL MARTIN

An important group of afferent impulses concerned with the maintenance of bodily equilibrium is derived through the semicircular canals and vestibule of the ear, which are supplied by the vestibular portion of the auditory nerve.

Experiment shows that cutting a semicircular canal is followed by violent movements of the head in the plane of the canal divided; the animal staggers, also, if made to walk; and, if a pigeon and thrown into the air, cannot fly. All its muscles can contract as before, but they are no longer so co-ordinated as to enable the animal to maintain or regain a position of equilibrium. It is like a creature suffering from giddiness; and similar phenomena follow, in man, electrical stimulation of the regions of the skull in which the semicircular canals lie.

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[1] Taken from *The Human Body* (10th ed.), pp. 236–39. (Revised by Ernest G. Martin.) New York: Henry Holt & Co., 1919.

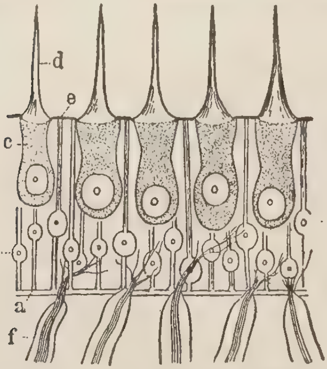

FIG. 47.—Diagram of epithelium in nervous region of ampulla of a semicircular canal.

If, moreover, a person lie perfectly quiet with closed eyes on a table which can be rotated, he is able to tell when the table is turned and in which direction, and often with considerable accuracy through what angle. If the rotation be continued for a time the feeling of it is lost, and then when the movement ceases there is a sense of rotation in the opposite direction. In such case neither tactile, muscular, nor visual sensations can help, and in the semicircular canals we seem to have a mechanism through which rotation of the head could give origin to afferent impulses, whether the head be passively moved with the rest of the body or independently by its own muscles. Movements of endolymph in relation to the walls of the canals may act as stimuli by causing a swaying of the projecting hairs of the ampullae (Fig. 47). Place a few small bits of cork in a tumbler of water, and rotate the tumbler; at first the water does not move with it; then it begins to go in the same direction, but more slowly; and, finally moves at the same angular velocity as the tumbler. Then stop the tumbler, and the water will go on rotating for some time. Now if the head be turned or rotated in a horizontal plane similar phenomena will occur in the endolymph of the horizontal canal; if it be bent sidewise in the vertical plane, in the anterior vertical canal; and if nodded, in the posterior vertical; the hairs moving with the canal would meet the more stationary water and be pushed and so, possibly, excite the nerves at the deep ends of the cells which bear them, and generate afferent impulses which will cause the general nerve-centers of bodily equilibration to be differently acted upon in each case. Under ordinary circumstances the results of these impulses do not become prominent in consciousness as definite sensations; but they are probably always present. If one spins round for a time, the endolymph takes up the movement of the canals, as the water in the tumbler does that of the glass; on stopping, the liquid still goes on moving and stimulates the hairs which are not stationary; and we feel giddy, from the ears telling us we are rotating and the eyes that we are not; hence difficulty in standing erect or walking straight. A common trick illustrates this very well: make a person place his forehead on the handle of an umbrella, the other end of which is on the floor, and then walk three or four times round it, rise, and try to go out of a door; he will nearly always fail, being unable to combine his muscles properly on account of the conflicting afferent impulses. This and the feeling of rotation in the contrary direction when a previous rotation ceases become readily intelligible if we suppose feeling to be excited by relative movements of the endolymph and the canals inclosing it.

The sense of equilibrium as mediated by the semi-circular canals is a dynamic sense, one dealing with equilibrium of motion. That we have also a static sense of equilibrium, which tells us our position when at rest is well known. The swimmer immersed in water knows perfectly whether he is on his face or on his back; whether his head is up or down. This static equilibrium sense is thought to be mediated by structures of the vestibule, the utricle and saccule. These are hollow structures having stiff hairs projecting into their cavities and tiny stones caught among the hairs. The weight of the stones will affect the hairs among which it rests in one way when the head is erect, in quite another way when the head is horizontal. Thus the nerves may be stimulated differently for different positions of the head, fulfilling the conditions that the sense requires. In many invertebrate animals structures similar to the utricle and saccule represent their only organs resembling our ears in any way. Experiments upon these animals have shown that in them these structures are not hearing organs but organs of equilibrium.

B[1]

BY LIGHTNER WITMER

Sensations of rotation and dizziness are associated with the disturbance of bodily equilibrium. The maintenance of equilibrium is dependent upon physiological processes which have three different sources: (1) the muscles, skin, and other structures associated in bodily movement; (2) the eyes; and (3) the three semicircular canals (see Fig. 44, p. 236) situated at one end of the inner ear. At the bases of these canals are sensory cells connected with nerve fibres which constitute a branch of the auditory nerve. These cells and fibres seem to have no function in relation to hearing. A movement of the head disturbs the liquid of the labyrinth, *i.e.*, the endolymph, and this in turn excites the sensory cells. Disease of the semicircular canals produces disturbance of the equilibrium, sensations of dizziness and nausea. The sensation of nausea is associated with the functions of the stomach, its particular source being the oesophagus. Sensations of rotation and dizziness cannot be ascribed to the semicircular canals alone; they are probably the mental result of a fusion of different physiological processes, some originating in the canals, but others, like the kinaesthetic sensation, in the structures usually excited by bodily movements, and still others in the internal organs, which are reflexly stimulated by an intense excitation of the sensory cells in the canals, conducted first to the brain and then by efferent nerves to the oesophagus and other internal organs.

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[1] Taken from *Analytical Psychology*, p. 185. Boston: Ginn & Co., 1902.

EXERCISE

1. Some say that we never directly sense the effects of movement upon the semicircular canals. What do you think about this? Would the fact that you would never have known about these sense organs of equilibrium, unless you had read about them, have any bearing on the matter?

6. GENERAL SENSIBILITY[1]

BY WALTER B. PILLSBURY

Of the sensations from the inner organs, hunger and thirst probably bulk largest in the daily life of man. Hunger has been recently investigated by Carlson and by Cannon. They find in man and dogs that it is a comparatively transient accompaniment of the deprivation of food. During a period from three to five days after food is stopped, the sensations become continually weaker and gradually practically disappear. They are, however, re-aroused by sight of food or by anything that suggests food. The sensations were found to be due to contractions of the walls of the stomach. Records of these contractions were taken by swallowing a rubber sack or balloon with tube attached which could be inflated to fill the stomach, and then registering, upon a revolving drum, the compressions of the air in the balloon. These contractions are particularly vigorous when hunger is keenest, and in general run parallel to the sensations. Thirst has its seat in the back of the throat. It is apparently due to the drying of the membrane there. It may be relieved by laving the back of the mouth with citric acid or by taking liquid into the system, either through the mouth, through an artificial opening into the stomach, or directly into the circulation. Each of these processes leads to the moistening of the membrane in question. In addition to the qualities of sensation discussed, there are a vast number of other sensations which fuse in the general complex of organic sensibility. It is useless to speculate upon their quality or their number. With the advance of science others will undoubtedly be separated from the mass and be recognized as separate senses; some already have names ascribed to them in popular speech. Of these, the more external of tickling, pins and needles, itching, have been explained in different ways; pins and needles by changes in circulation; tickling by contractions, in the skin muscles, survivals of the fully developed skin muscles in animals, or, by certain authors, as due to stimulation of tickle spots, a fifth form of sensory spot in the skin. No one of the explanations can be regarded as more than hypothetical. The internal sensations are even less known and few if any distinctive names can be given. Such names as are given refer to particular complexes, such as those present in the different emotions, rather than to specific sensations. Some of these inner sensations are of the same quality as the cutaneous sensations, and are always fused with sensations from the contraction of various muscles. They are most frequently fused into the vague feelings of well-being or ill-being, and are attended to only as signs of health or of general bodily state.

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[1] Taken by permission from *The Fundamentals of Psychology*, pp. 203–5. New York: Macmillan Co. Copyrighted, 1916.

EXERCISE

1. Why is it more difficult to detect and classify the elementary sensation qualities of the internal organs than it is those of the body surface?

CHAPTER X

ATTENTION

1. MANIFESTATIONS OF ATTENTION[1]

BY WALTER B. PILLSBURY

The manifestations of the state that we commonly call attention are protean. No part of the individual is untouched by them. They extend to every part of the physical organism, and are among the most profound facts of mind. So numerous and varied are the ramifications of attention, that we find it defined by competent authorities as a state of muscular contraction and adaptation, as a pure mental activity, as an emotion or feeling, and as a change in the clearness of ideas. Each of the definitions can be justified from the facts, if we put the chief emphasis now upon one phase and now upon another of its varied expressions. Each of these aspects must be discussed in turn, but for the present purposes we may confine ourselves to the immediate changes in conscious states, since these are most open to observation and seem to be fundamental for all the others.

Perhaps the best general description of the effect of attention is afforded by Wundt's comparison of consciousness to the field of vision. As in the eye there is a point of clearest vision, where all impressions are very distinct as opposed to the vagueness of the objects seen with other parts of the retina, so in mind there are always a few processes which stand out clearly, while the others are blurred and indefinite. And as the eye can wander over the various objects before it, bringing first one then the other into the most favourable position, so the sensations, of which we are conscious at one instant, disappear from consciousness at the next. Attention may wander over the mental field as the eye may wander over a surface in the outside world. Omitting the metaphor we may say that attention increases the clearness of the sensations attended to, but it is very difficult to describe what is meant by clearness in a way that shall make it any more easily understood. Every one knows what is meant by the term and has experienced the change which actually goes on during attention. It means largely that some one element of consciousness is picked out from the others, and given an advantage over them. It is more fully conscious, more adequately a part of our experience than are the others. Clearness is then purely a relative matter. All mental processes affect us in some degree, but those processes to which we attend affect us in a much higher degree than those to which we do not attend. Increase in the degree to which an impression is conscious and increase in attention to that impression are synonymous terms.

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[1] Adapted from *Attention*, pp. 1–11. London: Swan Sonnenschein & Co., 1908.

When we attend to a process we break it up into its elements, and many times into elements which we did not know to be present before the analysis took place. An object is given in a chaotic mass without any particular form, and it is only under the influence of the attention that it takes shape. First one bit or aspect of the process stands out, and then another, as the attention plays over it, and we get a real conception of the object only as the result of many different acts of the attention. It is hardly fair to say, however, that the function of the attention is always analytic, for just as frequently it partakes of the nature of a synthesis. It is just as possible for the minute elements to be seen first, and for them to suggest the whole, as for the whole to come first and be followed by the parts. And in many cases neither happens, but the attention selects first one, then another, of several co-ordinate aspects. What is selected is not so much a part of the given whole as a phase of the whole—a point of view from which to observe the total mass. The function of analysis then is not essential to the attention—in fact most cases of attention do not result in analysis. Rather may we say that attention is fundamentally a change in clearness of some one phase or aspect of a mental process. And while analysis depends upon that, it is not, as has been suggested, the prime effect, but is merely incidental to other functions, is, in fact, a result of the one thing which is characteristic of attention—the increase in clearness or prominence which it produces in some one idea, or of some aspect of that one idea. Increase in clearness is the only change which can certainly be affirmed to be the result of attention.

EXERCISE

1. Show how your paying attention to a chair, for example, both analyzes and synthesizes the world before you.

2. THE SCOPE OF ATTENTION[1]

BY WALTER B. PILLSBURY

This question is one that has played a considerable part in the older history of psychology and philosophy. It has long been a dogma of common sense, and was an accepted principle of the old rational psychology, that man can attend to but one thing at a time, that no more than a single impression can occupy the centre of consciousness at any given instant. The dogma undoubtedly has a purely a priori origin, and was deduced from the principle that the mind was a simple indivisible substance, and therefore could contain but one idea at a time. Recently this statement has been subjected to experiment and found not to be in harmony with the facts of experience, or at least not to be true in the naïve way in which it was formulated.

The experiments consist in exposing a number of objects for an interval of one-hundredth to one-fifth of a second—a time much too short to permit the impressions to be counted during the exposure—and noting the number of objects that can be correctly recognised in the period. Two facts of importance for our discussion were obtained. It was shown that four or five impressions could be noticed at one time instead of one, as the rational psychologists had assumed, and also that the number of objects which could be recognised was almost entirely independent of their size or complexity. Goldscheider and Müller found, for example, that it was as easy to perceive a complex group of dots arranged in some regular order, as it was to perceive a single dot, that the complex which goes to make up a letter is as easily recognised as the simplest impression. Finally it was found that a short word was seen as easily as a single letter. In spite of the great difference in size, and the greater number of elements in the word, it is in its connection just as much a single object as the single dot, and in spite of the fact that it is itself made up of letters, which in isolation are themselves objects, the word is as much a simple object as is any letter. This result is confirmed by the work on time of recognition first carried out by Cattell and repeated by Erdmann and Dodge. They all found that it took less time to recognise a word than a single letter, provided the word was short, and that words of eight letters were recognised as quickly as the separate letters.

There is a very similar set of facts in connection with auditory impressions. It was found that if a monotonous series of clicks were given in such rapid succession that counting was impossible, eight single sounds could be perceived in a single act of the attention. But if the sounds were rhythmically united into groups, either by varying the intensity of the external impression or by subjectively accenting some of the tones, it was possible to receive forty impressions in a single act of consciousness. That is, nearly as many rhythmical units could be noticed as single clicks. The combination into rhythmical groups renders the group a unit of the same kind as the single object.

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[1] Adapted from *op. cit.*, pp. 64–68.

These two groups of facts seem to show that what we call the object, the simple existing thing, is not so much determined by its physical characteristics as by the use to which it is put and the attitude of mind at the time they are perceived. A thing may just as well be large as small, complex as simple. It is equally unitary at the moment of perception, no matter how many different elements go to make it up. It is as easy to recognize a landscape as any single grain of sand that contributes to some simple feature of the view. If aspects or attributes, sensations or things, to speak metaphysically, psychologically, and popularly at once, have been used together, or have frequently come into consciousness at one time, they come to be regarded as a single object, they become isolated from everything else, and when they come to mind again they are treated as a unit. What determines the number and kind of elements that shall compose any object when there are several different combinations which can be made, is always the set of conditions that happens to be dominant in mind at that particular time. If the circumstances of the moment make the letter more important it will hold the chief place, will constitute the unit of perception at that time; if on the other hand the word is adapted to the mental setting of the moment, then it becomes the object of the moment and the letters are not seen separately. The same statement holds of the landscape and its elements, for the picture and its details, for the locomotive and the minute oil-hole upon some insignificant part. What determines which shall be regarded as the object is in every case the mental attitude, not the physical mass which is offered to consciousness.

EXERCISE

1. Upon what factors depends your answer to the question: How many objects can be attended to at once?

3. THE DURATION OF ATTENTION[1]

BY WALTER B. PILLSBURY

Corresponding to the problem of the number of objects to which attention may be given, is the question of the length of time that it is possible to attend to a single impression without flagging. That there are limits is a fact of daily observation. One cannot keep the attention directed to any line of work, however interesting or varied, without tiring and being compelled after a time to turn to something else. The length of time that one can apply oneself to these stronger impressions will of course vary with the individual, with his condition, and with the nature of the task. Its widest limits are marked by the length of the waking period of the day, and the time that can elapse before nourishment is required. There is no means of answering the question in this form. The truer test is how long one can attend to a single monotonous stimulation without losing it. When the student is engaged in studying even a single proposition the attention is constantly changing its direction and bringing out now one thing, now another. For stimuli of ordinary intensity there has been no investigation. It would probably offer a great many introspective difficulties, even if it were possible ever to reach a satisfactory result.

Much work has been done, however, on the limits of attention to very weak stimuli, with results that are interesting both in themselves and because of the light which they throw upon the general theory of attention. The first observations of the phenomenon were made by Urbantschisch, a German specialist in diseases of the ear. While testing one of his patients for accuracy of hearing, he found that with no change in any of the physical relations of the sound, there seemed to come an alternate dying away and reappearance of the sounds, and that this alternation took place at fairly regular intervals. Similar experiments were set on foot in other senses, and it was found that there was a constant alternation in slight sensations from all sense organs. There was a constant reappearance and disappearance of the sensation no matter how strongly the attention was kept upon the stimulus. Many elaborate experiments were made upon the phenomena by Lange and others at Leipzig and by Münsterberg, and all with very much the same results. The period of the fluctuation varies from 3 to 25 seconds with different persons and under different conditions, but is very much the same for the same person under one set of conditions. It is slightly different for the different senses, but not very markedly.

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[1] Adapted from *op. cit.*, pp. 69–71.

These experiments can all be repeated with great ease by any one. If you will hold a watch at such a distance from the head that its ticking is just audible, it will be noted that for several seconds the sounds will be heard and that they will then disappear for a second or so. This appearance and disappearance will alternate with considerable regularity. For sight it is most satisfactory to use a rotating disc of sufficient rapidity to mix colours thoroughly. If on a white disc of this kind you will paste a bit of black paper that will give a just noticeable gray ring when revolved, it will be seen that the ring comes and goes in very much the same way as the ticking of the watch, and at about the same rate. A still simpler method that will often prove successful is to make a dot upon a bit of paper and move away from the paper to a distance so great that the dot will be barely visible. It will then be noticed that the image of the dot comes and goes as did the gray ring. Any faint sensation will show the same alternations. A very light constant pressure, a weak electric current, or any other weak stimulus that suggests itself, may be used to advantage.

The same rhythmic alternation shows itself when, under any circumstances, two nearly equal stimuli of different qualities which will not combine are applied at the same time to the same sense organ. One good instance of this has already been noted in an earlier chapter in connection with the experiments of Dr. Breese on retinal rivalry (p. 314). The alternations between the colours presented to either eye go on at much the same rate, and are undoubtedly due to the same conditions as the coming and going of the faint stimulus. Dr. Breese found also that there would be a similar fluctuation if by means of mirrors two colours were thrown upon the same retinal area at the same time. Lange also found if a prism were drawn in ambiguous perspective so that it might be interpreted to be either concave or convex, it would be found that the two interpretations would succeed each other at regular intervals as soon as both became equally familiar. The rate of fluctuation, again, is not so very different from that of the same individual for the minimal stimuli or for retinal rivalry. Memory images undergo the same change. If you will think intently of some simple stimulus, it will be seen that it does not remain permanently before the mind, but comes and goes rhythmically in a way similar in every respect to the changes shown by the weak sensation.

EXERCISE

1. Can you suggest any biological reason why attention should naturally tend to fluctuate?

4. PHYSICAL CONCOMITANTS OF ATTENTION[1]

BY TH. A. RIBOT

The physical manifestations of attention are numerous and of very great importance. We shall minutely pass them in review, while forewarning the reader, that we consider them less as effects of this state of mind, than as its necessary conditions—frequently even as its constitutive elements. This study, accordingly, far from being subordinate to our purpose, is really an investigation of capital importance. To obtain an approximately clear idea of the mechanism of attention, we shall not have to look anywhere else. It is, in fact, only an attitude of the mind, a purely formal state; if we divest it of all the physical concomitants that determine and give it substance, we remain in the presence of a pure abstraction, a phantom. And so the psychologists that have only spoken of attention from inward observation, have remained silent concerning its mechanism, and have limited themselves to extolling its power.

It is always necessary to bear in mind the following fundamental principle: Every intellectual state is accompanied by definite physical manifestations. Thought is not,—as many from tradition still admit,—an event taking place in a purely supersensual, ethereal, inaccessible world. We shall repeat with Setchenoff, "No thought without expression"; that is, thought is a word or an act in a nascent state, that is to say, a commencement of muscular activity. The sensorial forms of attention so clearly testify to this principle that it cannot be questioned. The same applies to that internal, hidden process, called reflection, of which we shall speak later.

The physical concomitants of attention can be referred to three groups: vaso-motor[2] phenomena, respiratory phenomena, and motor phenomena, or phenomena of expression. They all denote a state of convergence of the organism and of concentration of labor.

Let us suppose that twenty persons fix their attention for five or ten minutes upon their little finger. In such case something like the following will happen. Some will be unconscious of any sensation whatever; others will experience certain distinct sensations, as suffering, pain, arterial pulsations; the majority will feel a faint impression of heaviness and a crawling sensation. This simple experiment raises the following questions: Do there not always exist in the several parts of the body sensations, due to incessant modifications of the tissues—modifications which pass by unperceived unless attention is fixed upon the same? Can the act of attention increase the vascular activity of the sensorial ganglia, and there produce subjective sensations? Finally, can the sympathetic centers be aroused? Can the vaso-motor nerves be so influenced as to produce certain transitory vascular modifications in the finger with which the sensation is connected?

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[1] Adapted from *The Psychology of Attention* (6th ed.), pp. 11–19. (Revised.) Chicago: Open Court Publishing Co., 1911.

[2] Pertaining to the dilation or constriction of the blood vessels.—Editors.

The first supposition seems probable only to a very slight degree. Indeed, it is always possible to experience a sensation in the finger, if we set about attentively to seek for this sensation.

But, we think that the two other suppositions are perfectly well grounded. The sensation experienced is perhaps partially subjective; but in our opinion, the finger, upon which thought is concentrated for a sufficient space of time, is really the seat of a sensation. The vascular modifications that take place are felt in the form of arterial pulsations, heaviness, etc.

The respiratory modifications which accompany attention resemble the motor phenomena proper, and enter partly into the feeling of effort. The rhythm of respiration changes, slackens, and sometimes undergoes a temporary stoppage. "To acquire the power of attention," says Lewes, "is to learn to make our mental adjustments alternate with the rhythmic movements of respiration. It is a felicitous expression, that in the French language, which designates a clever but superficial thinker, as one incapable of any work *de longue haleine*—of long breath." The yawning which follows a protracted effort of attention is probably the effect of the slackening of respiration. Often, in like instances, we produce a prolonged inhalation, in order to renew abundantly the air within our lungs. The sigh—another respiratory symptom—as several authors have pointed out, is common to attention, to physical, and moral pain: its object is to oxygenize the blood that has been narcotized by the voluntary or involuntary stoppage or respiration.

The movements of the body, which are said to express attention, are also of paramount importance.

In the first place let us examine the facts. They have not been seriously studied before our own time. Formerly only artists and a few physiognomists—both at all times too partial to their own fancies—had concerned themselves about them.

Attention (in order to mark it more precisely, we shall call it sensorial) contracts the occipitio-frontalis. The muscle, which occupies the whole region of the forehead, has its mobile point of insertion in the under surface of the skin of the eyebrow and its fixed point of insertion at the back part of the skull. In contracting, it draws to itself the eyebrow, lifts it, and produces a few transversal wrinkles on the forehead; consequently the eye is wide open and well illuminated. In extreme cases the mouth opens wide. In children and in many adults close attention produces a protrusion of the lips, a kind of pouting.

The act of reflection is expressed in another, and almost contrary manner. It acts on the superior orbicular muscle of the eyelids and lowers the eyebrow. As a consequence, small vertical folds are formed in the space between the eyebrows: the eye is veiled or completely closed, or it looks within. This wrinkling of the eyebrows imparts to the face an expression of intellectual energy. The mouth is closed, as if to sustain an effort.

Attention adapts itself to what is without, reflection to what is within. Darwin explains by an analogy the mode in which reflection expresses itself. It is the attitude of difficult vision, transferred from external objects to internal events that are difficult to grasp. Hitherto we have only spoken of the movements of the face; but there are, besides these, those of the entire body—of the head, trunk, and limbs. It is impossible to describe them in detail, because they vary with each animal species. In general a state of immobility sets in, adaptation of eyes, ears, and of touch, as the case may happen: in a word, there is a tendency toward unity of action—convergence. Concentration of consciousness and concentration of movements, diffusion of ideas and diffusion of movements go together. Let us recall the observations and calculations of Galton upon this subject. He observed an audience of fifty persons, listening to a long and tiresome lecture. The number of movements clearly discernible in the audience was very uniform: forty-five a minute, or, say an average of one movement for each person. Several times, the attention of the audience having been aroused, the number of movements decreased by one half; besides they were less extended, less prolonged, shorter and more rapid. I may incidentally anticipate an objection. Everybody knows that attention, at least, in its reflected form is at times accompanied by movements. Many people seem to find that walking to and fro helps them out of perplexity; others strike their forehead, scratch their head, rub their eyes, move their arms and legs about in an incessant, rhythmical fashion. This, indeed, is an expenditure, not an economy of motion. But it is a profitable expenditure. The movements thus produced are not simple mechanical phenomena acting upon our external surroundings; they act also through the muscular sense upon the brain, which receives them as it receives all other sensorial impressions, to the increase of the brain's activity. A rapid walk, a race, will also quicken the flow of ideas and words; they produce, as Bain says, a sort of mechanical intoxication. We stretch out our arms and legs to begin work; that is, we arouse the motor centres. Passive movements impressed upon paralyzed members, have in certain cases, been able, by reviving motor images, to restore lost activity. And it is to be observed, that the result of these movements is to increase mental activity, and not to concentrate the attention; they simply provide it with subject-matter. It is a preliminary operation only.

EXERCISES

1. What muscular contractions commonly take place in a subject trying to work in spite of some distracting sound?
2. What part do they play in aiding him to control his attention?

5. VOLUNTARY ATTENTION[1]

BY TH. A. RIBOT

Voluntary or artificial attention is a product of art, of education, of direction, and of training. It is grafted, as it were, upon spontaneous or natural attention, and finds in the latter its conditions of existence, as the graft does in the stock, into which it has been inserted. In spontaneous attention the object acts by its intrinsic power; in voluntary attention the subject acts through extrinsic, that is, through superadded powers. In voluntary attention the aim is no longer set by hazard or circumstances; it is willed, chosen, accepted or, at least, submitted to; it is mainly a question of adapting ourselves to it, and of finding the proper means for maintaining the state; and hence voluntary attention is always accompanied by a certain feeling of effort. The maximum of spontaneous attention and the maximum of voluntary attention are totally antithetic; the one running in the direction of the strongest attraction, the other in the direction of the greatest resistance. They constitute the two polar limits between which all possible degrees are found, with a definite point at which, in theory at least, the two forms meet.

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[1] Adapted from *op. cit.*, pp. 29–34.

The process through which voluntary attention is formed, may be reduced to the following single formula: To render attractive, by artifice, what is not so by nature; to give an artificial interest to things that have not a natural interest. I use the word "interest" in the ordinary sense, as equivalent to the periphrase: anything that keeps the mind on the alert. But the mind is only kept alert by the agreeable, disagreeable, or mixed action of objects upon it, that is, by emotional states. With this difference, however, that here the feelings that sustain attention, are acquired, superadded, not spontaneous, as in its primitive manifestations. The whole question, accordingly, is reduced to the finding of effective motives; if the latter be wanting, voluntary attention does not appear.

Such is the process in general; in practice, however, it becomes infinitely diversified.

In order properly to understand the genesis of voluntary attention, the best way will be to study children and the higher animals. The simplest examples will prove the most instructive.

During the earliest period of its life the child is only capable of spontaneous attention. It fixes its gaze only upon shining objects, and upon the faces of its mother or nurse. Toward the end of the third month it explores its field of vision, by degrees allowing its eyes to rest upon objects less and less interesting (Preyer). The same takes place in regard to the other senses; there is a slow transition from that which is of greatest concern to that which is of least concern. The fixing of the gaze, which later becomes intense attention, is outwardly expressed by the more marked contraction of various muscles. Attention in the infant is accompanied by a certain emotional state, which Preyer calls "the emotion of astonishment." At its highest point, this state produces a temporary immobility of the muscles. According to Dr. Sikorski, "astonishment, or rather the emotion that accompanies the psychic process of attention, is chiefly characterized by the momentary suspension of respiration—a striking phenomenon indeed, after being accustomed to the rapid respiration of children."

So long as the psychic life thus remains in the tentative epoch, attention, that is, the transfer of the mind from one object to another, is determined only by the objects' power of attraction. The birth of voluntary attention, the power of fastening the mind upon non-attractive objects, can only be accomplished by force, under the influence of education, whether derived from men or things external. Education, derived from men, is, of course, the most easily demonstrable, but it is not the only kind.

A child refuses to learn how to read; it is incapable of keeping its mind fixed upon letters that have no attraction for it; but it will gaze with eagerness upon pictures in a book. "What do those pictures mean?" Its father answers: "When you know how to read, the book will tell you." After a few talks of this kind the child finally gives up; at first it sets about the task lazily, but afterwards it becomes accustomed to its work, and finally evinces an eagerness that needs to be checked. In this we have an instance of the genesis of voluntary attention. It was necessary to graft upon a desire natural and direct, a desire artificial and indirect. Reading is an operation that does not possess an immediate attraction, but as a means to an end it has attraction—a kind of borrowed attraction—and that is sufficient: the child has been caught in a wheel-work, as it were, and the first step has been accomplished. The following is another example from B. Perez. "A child six years old, habitually very *inattentive*, went to the piano one day, of its own accord, to repeat an air that pleased its mother; and it remained there for over an hour. The same child, at the age of seven, seeing its brother engaged about some of his holiday-duties, entered and seated itself in its father's study. 'What are you doing?' asked the nurse, astonished at finding the child there. 'I am doing a page of German; it is not very amusing; but I wish to give Mamma a pleasant surprise.'" Here we have another case of the genesis of voluntary attention, this time grafted upon a sympathetic, and not upon a purely selfish feeling as in the former example. The piano and the German lesson did not spontaneously evoke attention; they awaken and maintain it through the medium of a borrowed force.

In every instance of the origination of voluntary attention this mechanism is invariably found to be the same,—but in endless variations, resulting in success, half-success, or failure: ever grasping natural motives, diverting them from their direct purpose, using them, if possible, as means for another end. Art bends nature to its purposes, and for this reason I call this form of attention, artificial.

Without assuming to enumerate all the different motives that artifice puts into play, in order to call forth and to consolidate voluntary attention, that is,—to repeat once more my former statement,—

in order to impart to the purpose in view a power of action that it naturally does not possess, I shall now indicate three periods in point of time into which voluntary attention falls.

In the first period, the educator acts only upon simple feelings. He employs fear in all its forms, egotistic tendencies, the attraction of rewards, tender and sympathetic emotions, as well as our innate curiosity, which seems to be the appetite of intelligence, and which to a certain degree—no matter how weak—is found in everybody.

During the second period, artificial attention is aroused and maintained by means of feelings of secondary formation, such as love of self, emulation, ambition, interest in a practical line, duty, etc.

The third period is that of organization; attention is aroused and sustained by habit. The pupil in the class-room, the workman in his shop, the clerk at his office, the tradesman behind his counter, all would, as a rule, prefer to be somewhere else; but egotism, ambition, and interest have created by repetition a fixed and lasting habit. Acquired attention has thus become a second nature, and the artificial process is complete. The mere fact of being placed in a certain attitude, amidst certain surroundings, brings with it all the rest; attention is produced and sustained less through present causes than through an accumulation of prior causes; habitual motives having acquired the force of natural motives. Individuals refractory to education and discipline never attain to this third period; in such people voluntary attention is seldom produced, or only intermittently, and cannot become a habit.

EXERCISE

1. What relationships can you notice between voluntary attention and habit?

CHAPTER XI

PERCEPTION

1. GENERAL STATEMENTS ON PERCEPTION

A. The Nature of the Process of Perception[1]

BY ALFRED BINET

Perception is, from the common-sense point of view, a simple act, it is a passive state, a kind of receptivity. · To perceive an external object, our hand for example, is simply to be conscious of the sensations which the object produces on our organs. Some examples will, however, suffice to show that in every act of perception, the mind constantly adds to the impressions of the senses. Everybody knows that we can hear the words of a familiar song clearly, while we are frequently unable to distinguish those of an unknown song, even when both songs are sung by the same voice, a fact which plainly shows the share due to the mind. Instead of our seeking examples, proofs may be produced. Wundt and his pupils have made several experiments on this subject. An unknown sketch, an engraving, is illumined by a series of electric sparks, and it is noted that the perception of this sketch, while very much confused during the first sparks, becomes more and more distinct. The impression produced on the retina is nevertheless the same at each flash; but the perception becomes each time more complete and precise, by the help of the recollection formed in the mind by the preceding perceptions. One might add some more examples drawn from the perception of space, the complex and secondary character of which has been known to us since the days of Berkeley.

Perception is therefore a mixed state, a cerebro-sensory phenomenon produced by an action on the senses and a reaction of the brain. It may be compared to a reflex, the centrifugal period of which, instead of manifesting itself externally in movements, would be expended internally in awakening associations of ideas. The discharge follows a mental channel instead of a motor one.

But psychology demands a larger measure of precision. It is not enough to say that in every perception there are sensations and something more which the mind adds to the sensations. What is the nature of this addition? This question may be best answered by the study of the illusions of the senses. It is now known that in such illusions the error is not to be imputed to the sensitive organ, as the ancients believed, but to the mind. An illusion is a mixed phenomenon, composed, like the sensory perception of which it is a counterfeit, by the co-operation of the senses and the mind. The sensory impressions are always what they ought to be, the nature of the external excitant and the state of the sensitive organ being given. The error lies in the co-operation of the mind, in the interpretation of the sensations. Now, the examination of some illusions will be sufficient to show in what this co-operation of the mind consists, and what is to be understood by an interpretation of sensations.

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[1] Taken from *The Psychology of Reasoning* (3d ed.), pp. 4–8. (Translated by Adam Gowans Whyte.) Chicago: Open Court Publishing Co., 1912.

One of my friends, now a university professor, has related to me this story of his youth. One evening, when he was walking alone in a country broken up by large woods, he perceived, in a clearing, a large fire lighted. Then, immediately after, he saw an encampment of gypsies around this fire. There they were, with their bronzed faces, lying on the ground and engaged in cooking. The night was dark, and the place very lonely. Our young man was afraid, he lost his head completely, and, brandishing the stick he held in his hand, he dashed furiously into the gypsies' camp. A moment after he was in the middle of a pond, convulsively clasping a tree-trunk with his arms, and feeling the chill of water which rose as far as his knees. Then he saw a will-o'-the-wisp flickering on the surface of the pond; it was this shining spot which had been the starting point of his sensory illusion.

I owe the following account to another of my friends, Dr. G. A. One day when he was ascending the Rue Monsieur-le-Prince in Paris, he thought he read on the glass door of a restaurant the two words *verbascum thapsus*. This is the scientific name for one of the scrophulariaceae of our country, which is commonly called "bouillon blanc." My friend had passed the preceding days in preparing for an examination in natural history; his memory was still surcharged with all those Latin names which render the study of botany so tiresome. Surprised at the inscription which he had just perceived, he retraced his steps in order to verify its accuracy, and then he saw that the tariff of the restaurant bore the simple word "bouillon." This word had suggested "bouillon blanc" to his mind, and this in turn had suggested *verbascum thapsus*.

These are two cases in point. They show us the composition of the element which the mind adds to sensation in the perception of external objects. This element must bear a remarkable resemblance to sensations, since it is indistinguishable from them. The young man who traverses a forest really believes that he sees before him a band of gypsies; all this phantasmagoria comes from a brain rendered delirious by fear; it is a psychological phenomenon which, whatever its nature, is very nearly related to sensation, since it does duty for it. Similarly Dr. A. believes he sees written on the door of a restaurant words which exist only in his mind; for this confusion to be possible it is necessary once again that the mind should have the power of producing, of manufacturing and of objectivizing certain simulacra which in a striking manner resemble sensations.

For several years past these pseudo-sensations have attracted the special attention of psychologists. They are called *representations* in Germany. In France the prevailing term is *images;* it is this which we shall use.

A definition of sensory perception will form the conclusion of this short introduction: Perception is the process by which the mind completes, with the accompaniment of images, an impression of the senses.

B. The Influence of Past and Anticipated Experience upon Perception[1]

BY LIGHTNER WITMER

The perception of an external object is determined by apperception as well as by sensation.

Turn over the page and look at Figure 48. What do you see at the first glance? Is it a staircase? Does your first perception remain? Can you see a staircase as though viewed from underneath? Can you see the figure as an arrangement of black lines drawn without perspective on the plane surface of the figure?

This figure is often called the staircase illusion. It is really not an illusion, unless all perception is an illusion. The external object, or *stimulus*, which acts upon the sense organ of vision is a certain number of black lines upon white paper. Whatever comes into your mind, when the eyes are directed to the figure, is called a *mental content.* If you see only "black lines on the white surface" the mental content is relatively simple. When the mental content is more complex,—for

[1] Adapted from *Analytical Psychology*, pp. 1–6. Boston: Ginn & Co., 1902.

example, the perception of the drawing of a staircase,—the complexity is due not to the lines of the figure actually before your eyes, but to former perceptions of staircases, drawings, and similar objects that have been seen, touched, and handled. By virtue of this experience, the mind itself contributes more to the formation of the present perception than does the action of the physical stimulus upon the sense organ. For this reason, the mind is said to *apperceive* the external object.

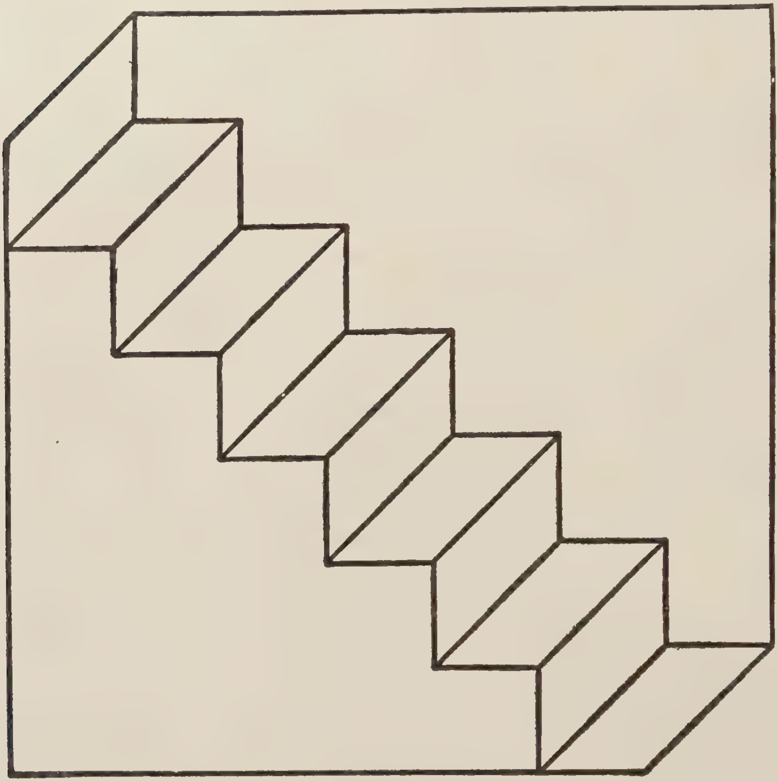

FIG. 48

It is easier and more "natural" to perceive the figure as a "staircase" than it is to see merely "black lines on white paper." In fact, we seem to perceive "the staircase" as immediately and instantaneously as we hear the sound of a bell or feel the heat of a stove. The mental contents with which we *react* or *respond* to the sound of the bell, the heat of the stove, and the black and white of the chart are the results of the *process of sensation*, a native or inborn capacity of every one possessed of normal sense organs and brain. The perception of "staircase," on the other hand, is only in very small part due to sensation. It is chiefly the product of a mental process, called *apperception*, that is formed and developed, through experience and education, during the life of each individual human being. This development is reflected more particularly in the acquisition of memories of former experience, and in the formation of new habits. In accordance with the character and number of these memories and habits, a mind reacts to a simple stimulus so as to form a complex mental content, called a *perception* of the object. Every perception is a *synthesis*, or combination, of the part contributed by apperception and the part contributed by sensation. What is received by the mind through sensation is always supplemented and elaborated by the *process of apperception*. The progressive growth and modification of each individual mind is called its *ontogeny*. Through apperception, therefore, is affected an *ontogenetic elaboration* of the simple mental contents that are the bare results of the stimulation of sense organs.

It is often difficult to demonstrate the contribution of apperception so as to distinguish it from that of sensation, because the completed perception usually seems to be an unanalyzable unit directly and entirely inspired by the stimulus. The experiment with the staircase figure makes this distinction clear. One and the same stimulus is shown to give rise to two different perceptions. This cannot be due either to the stimulus or to sensation, because the eyes and the brain are stimulated in each case by the same physical object. Neither perception is an illusion; "the staircase from underneath" is as true a perception of the lines as is "the staircase from above," although the latter perception is the more readily formed in many minds. A figure drawn without definite perspective is called an *equivocal* figure, because the stimulus is not able to elicit decisively any one of the possible contributions of apperception. In consequence, your neighbor's mind may not react to a given stimulus with a mental content similar to yours, nor need your mind react at all times with the same perception; but all minds will manifest at all times an apperceiving tendency to supplement and elaborate, in some way, the mental results of the action of a stimulus upon the sense organ.

A perception may be determined by the association of an anticipating mental image or idea of the object—i.e., by preperception.

Look again at Figure 48. Can you see this figure as a strip of cardboard extending obliquely from the upper left-hand corner to the lower right-hand corner, bent at right angles like an accordion plait, and situated in front of the plane of the apparent background? The outline of the figure will then give the perception of a continuous plane surface, a background, in front of which is suspended the plaited strip. Can you vary the angles of the plait, causing them to appear at will as either right, obtuse, or acute angles?

This perception of the figure is often more difficult to obtain than the "staircase" perceptions. It is therefore necessary to think vividly beforehand of what you expect to see. The anticipation of a perception by a thought, idea, or mental image is called *preperception.* Some may be unable to see even the "staircase from underneath," until, through attention to what is expected to be seen, apperception is assisted by a vivid preperceiving image. It is important to distinguish *associated preperception* from apperception. When the words, "Do you see an accordion plait?" are seen or heard, they are associated with a visual image of the object indicated by the words. This visual image, due to the *reproductive process of memory,* is in turn associated with the lines on the paper as these may have been originally perceived, either as "lines" or as a "staircase." Through this associated preperceiving image, the simpler visual sense perception is supplemented and modified to correspond to the particular object of preperception.

When this new perception does find place in consciousness, it will seem to be as directly inspired by the figure, and as natural, as did the perception of "staircase." Associated preperception accomplishes the same final result in the formation of a perception as does apperception. When the "staircase from underneath" and the "accordion plait" perceptions are once obtained, it may be difficult to keep any one perception in mind to the exclusion of others; a continuous and unavoidable fluctuation from one perception to another will be observed. It appears from these experiments that the apperceiving tendency to react to the stimulus so as to form a perception of "staircase from above" is already perfected by most minds, whereas a similar tendency to perceive "staircase from underneath" or "plait" is developed only with the assistance of a preliminary association of definite and more or less vivid memory images. The perception of "staircase," which arose in mind at first sight without consciousness of any preceding associated image, is dependent upon an apperceiving tendency also originally developed from associated memories of similar perceptions. These memories, however, do not have conscious or psychical existence at the moment of perception. Their influence in the past can only be inferred from the increased complexity of the present perception. Such modification of the apperceiving process as may be attributed to them is accomplished.

C. Dependence of Perception upon the Individual[1]

BY CARL EMIL SEASHORE

All perception is inceptive interpretation. Among different persons viewing the same point in a landscape under exactly similar outward conditions, the botanist sees the cause for the shape of the overhanging tree, the artist sees effective shadows for the setting of a sketch, the carpenter sees a good location for a cottage, the farmer sees the rich clover going to waste, and the summer girl sees the location for a romance.[2] "We see things not as they are but as we are" (Patrick).

And let a man recall what he has seen in a familiar landscape as a child, as a ball-player, as a lover, as a real-estate investor, as a naturalist—in happy moods or in gray moods, in company or alone. No matter how constant the outward features, he has always seen in the landscape just what it meant to him in the light of his knowledge, needs, and tendencies of the moment.

All interpretation is partial. It is confined to the limits of the sense-organs, the time, opportunity, and inclination for detailed scrutiny, habits of inference, the purpose in mind, the store of knowledge about it, etc. These facts are so universal that we scarcely take cognizance of them. Before the psychologist was interested in the doctrine of apperception, schoolboys delighted in reciting the happy story of the six blind men of Indostan who went to see the elephant. The essential lines suffice for quotation:

First blind man, falling against the elephant's side:
"God bless me! but this elephant
Is very like a wall."

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[1] Taken from *Elementary Experiments in Psychology*, pp. 146–48. New York: Henry Holt & Co., 1908.

[2] Speaking of a certain ink-blot, one writer says: "To the hunter it is a beaver or a woodchuck; to the naturalist, a hedgehog or a flounder, according as his mind has been most directed to land animals or fish; to the mason, a trowel; to the keeper of pets, an Angora cat" (Colgrove).

Second blind man, feeling the tusk:
"This wonder of an elephant
Is very like a spear."

Third blind man, grasping the squirming trunk:
"I see," quoth he, "the elephant
Is very like a snake."

The fourth blind man, clasping the knee:
"'Tis clear enough, the elephant
Is very like a tree."

The fifth blind man, catching the ear:
"This marvel of an elephant
Is very like a fan."

The sixth, seizing the swinging tail:
"I see," quoth he, "the elephant
Is very like a rope."

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong.

The interpretation is personal; it is an act for itself. We can never fully perceive anything without falling into a cluster of associations which are peculiar to ourselves. How does the salad taste? That depends upon the season, how much one has eaten, one's preference for certain dressing, the stage of dyspepsia, and the attitude toward the hostess and the cook. What do you see in this picture? The reflection of something in yourself. It is a happy freak of nature that so many men sincerely marry the "best woman on earth," and that their children are the most wonderful children in the community.

EXERCISES

1. It is sometimes said that a perception is a complex reaction of an organism to its environment. In what sense is this true?
2. Cite from your own experience concrete examples illustrating the dependence of perception upon (*a*) past experience, (*b*) anticipation, and (*c*) the particular individual doing the perceiving.

2. ILLUSIONS[1]

BY GEORGE MALCOLM STRATTON

From time immemorial, the errors of sense have been pointed to as a proof of the unreliability of our powers. How can we be sure of anything, when our simplest faculties, our processes which come closest to external reality, are so deceptive? But this is only one side of the case. There is also the other side, that we not only have illusions, but we know that we have them; and the power of detecting them ought to give us quite as much ground for congratulation and self-confidence as the illusions themselves do for distrust. If it were not for the general soundness of our life, we should never be aware that anything was amiss. So that no doctrine of total intellectual depravity can ever be supported by appeal to the deceptions of sense. They are rather an evidence that in the perceptual life, as elsewhere, there is a mingling of good and evil, of true and false. And since experience shows that along with the errors comes also the power of correction, knowledge is in the ascendant, and the future is secure.

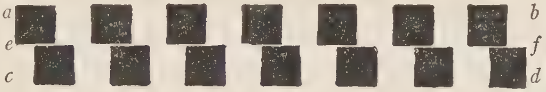

FIG. 49.—Münsterberg's figure (slightly modified)

Shall we conclude, then, that a more perfect mental adjustment will free us from illusions? It might seem from what was said earlier that such would be the case. If illusions spring from misinterpretation,—spring not from our sensations, but from the way we mentally supplement our sensations,—it would seem that when once we knew the truth the illusions would be dispelled. As a fact, however, many illusions will not down even when we know their character. Even after we know, for instance, that the contiguous edges of the squares in Münsterberg's figure (Fig. 49) run parallel to the lines *ab* and *cd*, the appearance remains contrary to this knowledge. And we may measure with compasses and convince ourselves that the lower of the concentric arcs above the horizontals in Fig. 50 is the continuation of the curve below the lines, and yet the upper persistently appears to have this character; and so with a host of other illusions. The fact that further knowledge does not destroy their sensible force demonstrates how complicated the mind is, and what inconsistencies it can harbor.

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[1] Taken by permission from *Experimental Psychology and Its Bearing upon Culture*, pp. 115–21. New York: Macmillan Co. Copyrighted, 1908.

Our modes of interconnecting and interpreting our sensations are due to deep-seated mental habits, lying beyond the immediate control of our will, and even to a large extent beyond the influence of logical evidence. They have become ingrained through the hard schooling of years and, possibly, of generations. The judgment from the evidence, however,—our knowledge of what the unperceived facts behind the illusions are,—lies on the surface, and does not penetrate into the deeper mental constitution. Illusion is consequently compatible with perfect knowledge; and a higher mental plane would assure us only of the power to see through all deceptions, but would be no guarantee that the illusions themselves would disappear. They would simply lose their power to mislead us; they would not be *delusions*, nor would they in any wise obscure our practical and moral relations. As soon as we are able to see around or through an illusion, it is no longer a hindrance, no longer a handicap, and consequently the process of natural selection or of adaptation to the environment cannot be depended upon to eradicate it. In fact, we may go farther than to say that illusions will continue because there is no especial need of our ridding ourselves of them, or that they will remain by inertia, for want of an opposing force. There is a positive utility of a higher kind in certain illusions. Judged by the standards of biology, they are defects; they are signs of an imperfect adaptation of the mind to its environment. But this is only half the truth. They are deficiencies that leave us the richer. For, having discovered that they exist, mankind makes them of service in that half-practical world of play and art. How much of the fascination of picture and of drama depends upon the light veil of illusion that floats over the whole, so fine that we at once see it and see through it. We have here the curious pleasure of being deceived and yet a party to the fraud. If the deception were perfect,

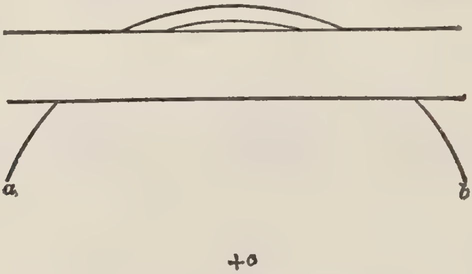

FIG. 50.—The lower of the arcs above the horizontal is the continuation of the curves *a* and *b*. (Verified by measuring from the center *c*.)

it would be mere trickery; and yet, too, if there were no deception, we should lose some subtle charm. If illusions, then, are to be described in prosaic scientific terms as cases of defective adaptation, may the defect in some faint form continue in this life and in the world to come!

In concluding, let us recall the main teaching of illusions in regard to the character of the mind. They show the interplay of the different sides of consciousness. Attention influences judgment, and expectation affects sensation. There are no sharp borders here. The usual divisions we make in psychology are not divisions in the facts themselves; there are no functions which act in isolation and without mutual dependence. Illusions, then, bring home to us the organic unity of the mind; they make it evident that the various sides are in constant sympathy and interaction, and that to some extent each participates in all that is done.

But the more specific teaching is as to the manner in which experience is constructed. Illusions, when understood, are the most striking refutation of the common belief that experience is a kind of direct impress of external nature, we being passive recipients of the facts as the world imprints them upon our senses. There is a passage in the *Theaetetus* which sounds odd enough to our modern ears, but which seems to be a foreshadowing of the truth. From the outer object, Plato tells us, there comes an image toward the eye; and out from the eye there flows sight to meet the object. The union of these two somehow produces our actual perception of the thing. Curious as we may account this early psychology, it expresses the truth that experience arises by a union of two different factors—something which comes from the outer world, and something which we ourselves contribute from our inner store. The outer impression alone, according to Plato, is not enough; we must do our part; we must meet the impressions half way. The outgoing sight darting from the eye to meet the image coming from the object, seems to represent what we now call our subjective elaboration of the incoming impressions—represents the associations or suggestions which these impressions arouse,—the form or arrangement into which we force them, and without which the bare sensations would have no meaning whatever.

So long as our contribution to the experience—the associations, the suggestions, the "form"—is in perfect keeping with the outer facts, we might well believe that external nature itself was the sole and efficient cause of our panorama of the world, that we had really received the experience bodily from the objects themselves. But the frequency of deceptive experiences, of perceptions contrary to fact, makes us see that this cannot be; that we ourselves are all the while a chief source of experience. Deprived of the outer world, we should indeed be without the crude materials of experience; but the finished product, the real vision of nature and of history, depends quite as much upon us. The world, then, is beheld by us only indirectly, as we reconstruct it out of our sensations. Like the Lady of Shalott, each of us views the gay pageant of life as in a glass, and even this reflected image comes to us only as we keep to our task. Once we cease our activity, once we stop our weaving, at that instant—as in the poem—the glass breaks, the vision vanishes, and around us lies but the tangled web of meaningless impressions. The chief psychological significance of illusions, then, is to bring out the fact that the mind, even in what appears its most passive moments, is in ceaseless activity, and that its various powers of intellect and feeling and will constantly interplay. These illusions thus force us to the paradox that our very deceptions are an important instrument of knowledge.

EXERCISES

1. Why are illusions natural products of training and education?
2. How do illusions help us to understand the normal activities of mind?

3. HALLUCINATIONS[1]

BY GUSTAV STÖRRING

Writers contrast hallucinations with *illusions*, which are, according to them, deceptions of sense due to falsification of actual perception by supervenient subjective elements. On this view, then, hallucinations and illusions alike are deceptions of sense; they both fall within the sphere of sense-perception; and this differentiates them from deceptions or delusions of judgment. There appears to be actual real sensation; as a matter of fact, there are only subjective sense-images.

All the same, there are some writers who do regard them as delusions of judgment, but the incorrectness of this view is easily seen when an illusion or hallucination is combined with a false judgment; for if you ask, Where precisely does the anomaly lie, in the function of judgment or in that of perception? the answer will certainly be that it lies in the latter.

Hallucinations are furthermore distinguished from other kinds of sense-deceptions which are not purely individual, such as the perception of a stick half-immersed in water as broken, or the duplication of an object of vision looked at through a prism. Hallucinations are purely individual phenomena, depending on some psychical abnormality in the percipient subject. They are "subjective sense-images," which strike him as actual perceptions; he is *convinced that he is actually perceiving;* in a word, to use the ordinary phrase, they possess *objectivity.* The strength of this conviction of actuality in persons who have hallucinations is a matter of frequent observation. "These voices," says a patient to his doctor, "seem to me just as distinct as your voice, and if I regard your words as actual, so I must the other words which come to me, I know not whence; I hear them just as I hear you."

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[1] Adapted from *Mental Pathology in Its Relation to Normal Psychology*, pp. 19–21. (Translated by Thomas Loveday.) London: Swan Sonnenschein & Co., 1907.

Moreover, *hallucinations have far more influence than simple perceptions upon intellectual and volitional process.* So far as their content constitutes an affirmation, it is taken as true; whilst those that challenge to action, or are in content closely connected with the idea of an action, exercise an unusual compulsion upon the will. Here is a case—I will not go into details—which illustrates the latter point. A patient of mine, who suffered from hysterical insanity, often heard in the evening and at night the voice of her father, who was dead, calling her to him in heaven, and thereupon she would run to the window, and looking up to heaven, would talk aloud to him for hours at a time. As her conduct disturbed the other patients, the doctor asked her to desist from it; but, though she saw clearly enough that the request was entirely reasonable, and, indeed, resolved not to behave in that way again when she heard the voice, her resolution, as was to be expected, had no effect whatever upon her actions.

Hallucinations are usually divided into two great groups—*elementary* and *complex.* In the elementary type the content of the fallacious perception is such as to indicate but little co-operation on the part of the ideational centres: flames or sparks or pillars of fire are seen, or sounds heard of rustling, cracking, and the like. In complex hallucinations words are heard and forms seen.

EXERCISE

1. Are dreams hallucinations or illusions? Why?

4. HOW PERCEPTION OPERATES IN READING

BY G. T. BUSWELL

The reading process furnishes an excellent opportunity for an objective study of the characteristics of perceptual habits. To the ordinary observer reading consists of a process of moving the eyes steadily along the lines of print while the reader interprets the perceptual stimulations which are registered. If, however, one observes the behavior of the eyes more closely he will note that instead of a steady movement along the printed lines the eyes cover the material by a series of quick movements and pauses. During each pause the eye takes in a certain unit of material and then rapidly moves on.

While direct observation will reveal the general nature of these eye-movements and pauses, it is very desirable to secure a more detailed analysis of these perceptual habits. Such an analysis is made possible by the use of an elaborate photographic device, by means of which an exact record of all the horizontal movements of the eye is obtained. This apparatus photographs, upon a continuously moving film, the reflection of a beam of light reflected from the cornea of the eye into the lens of a specially constructed camera. When this film record is plotted it reveals the exact point in the printed lines upon which each successive fixation pause occurs and also the duration of the pause in time units of one twenty-fifth of a second.

The character of the reading process is greatly clarified by an analytical study of these records. Such a study reveals three outstanding characteristics of perceptual habits in reading.

The first of these characteristics is the span of perception—the amount of material taken in at a single fixation-pause. The size of this perceptual unit varies greatly, being affected by such factors as the stage of maturity of the reader, the difficulty of the material, the purpose which motivates the reading, whether reading is oral or silent, etc. A study of the growth of this factor shows a negatively accelerated curve of the ordinary type (see page 156). An investigation based upon the silent reading of 179 subjects selected from all school grades from the first up to the college level showed that the median number of fixations per 3 1/2 inch line was in the first grade 18.6 while for the college students it was only 5.9. One of the fundamental demands of mature reading is the ability to grasp a wide unit of material in a single fixation-pause.

A second outstanding characteristic of perception in reading is the duration of the fixation-pause. Here again there are wide variations, but there is a progressive decrease in the duration of the pauses as the reader becomes more mature. The growth curve, in the investigation mentioned in the preceding paragraph, shows a median fixation time for subjects in the first school grade of 16.5 twenty-fifths of a second, while the median for the college subjects was 6.3 twenty-fifths. There seems to be a physiological limit to the speed of perception, no subjects having been found with a median perception time of less than 4 twenty-fifths of a second. It is evident that rapid reading must involve either a wider unit of material taken in at each fixation-pause or a more rapid perception of whatever unit the eye does perceive, or a combination of both. A study of reading records reveals that there is considerable independence between these two factors. Some readers adjust themselves to the demands of speed by widening their span of recognition, some make the adjustment by decreasing the duration of the perception pauses, while others simultaneously widen their perception span and decrease their fixation time.

A third characteristic of perceptual habits is the degree of regularity with which the eye proceeds along the line. For immature readers, the photographic records reveal frequent movements in the backward direction. These so-called regressive movements interfere greatly with the efficiency of reading habits. They are generally caused by some difficulty which requires a more detailed analysis from the reader. Children make many such regressive movements; mature readers make few in reading ordinary material. Where the number of regressive movements per line becomes very large it produces a series of oscillating eye-movements which seriously interfere with the reading process. If such a situation becomes extreme it changes the mental process from one of reading into one of analysis. An excellent example of such a break-down of reading habits is afforded by the reading of Latin. Third year high-school subjects have been found who in reading ordinary English material make 6 fixations per line, but when confronted with simple Latin, they make as many as 52 fixations per line, many of which were of the regressive oscillating type. Such a process as the latter cannot be characterized as reading; it is purely a deciphering, analytical process. It is perceptual behavior of the same sort as that exhibited by a beginning reader at the primary grade level. The more mature reader makes few regressive movements and proceeds across the line of print in regular, rhythmic series of eye-movements.

The development of mature perceptual habits in reading involves three principal factors: first, a widening of the perceptual unit until the reader can include several words in his span of recognition; second, the development of more rapid recognition of whatever unit of material is perceived; and third, the setting up of habits of regular, rhythmical eye-movements along the printed lines. This development of perceptual habits accompanies and is a symptom of the more mature mental processes involved in the comprehension of meaning.

The perception of the meaning of what is read does not result in the arithmetical addition of the words making up the sentence. Rather, a process of fusion is involved, by means of which the words are perceived in thought groups, with little attention to their individual meanings. The more mature the reader, the more comprehensive these fusion habits become. An adequate perception of meaning is therefore dependent upon a type of visual perception which enables the reader to receive a sensory impression of the reading material in relatively large units, without the necessity of analysis, and with the minimum of attention to the mechanical aspects of the process.

The printed material is not actually perceived in all its detail by the reader. In the rapid movements of the eye from pause to pause many letters or even words may escape observation altogether. The mature reader, however, fills in from his past experience sufficiently to make the meaning clear and continuous. In this manner misspelled words, or even omitted words are frequently read as they need to be in order to make the meaning clear. This oversight of minor elements is clearly illustrated when the amateur attempts to do proofreading. The direct vision of the eye is supplemented somewhat by peripheral stimulation, but when the mind is concentrated upon the content of what is read rather than the details of form, the reader supplies what he fails to see in order to get a complete meaning. This is clearly revealed in eye-movement records by the necessity of making many more fixations per line when the content is unfamiliar or particularly difficult.

EXERCISES

1. Why is proofreading difficult? How would you expect familiarity with the material treated to influence the accuracy of one's proofreading?
2. Why are we not conscious of the fact that our eyes are alternately moving and stationary as we read a line of print?

5. THE PERCEPTION OF TIME AND RHYTHM

A[1]

BY WILLIAM JAMES

WE HAVE NO SENSE FOR EMPTY TIME

Although subdividing the time by beats of sensation aids our accurate knowledge of the amount of it that elapses, such subdivision does not seem at the first glance essential to our perception of its flow. Let one sit with closed eyes and, abstracting entirely from the outer world, attend exclusively to the passage of time, like one who wakes, as the poet says, "to hear time flowing in the middle of the night, and all things moving to a day of doom." There seems under such circumstances as these no variety in the material content of our thought, and what we notice appears, if anything, to be the pure series of durations budding, as it were, and growing beneath our indrawn gaze. Is this really so or not? The question is important, for, if the experience be what it roughly seems, we have a sort of special sense for pure time—a sense to which empty duration is an adequate stimulus; while if it be an illusion, it must be that our perception of time's flight, in the experiences quoted, is due to the *filling* of the time, and to our *memory* of a content which it had a moment previous, and which we feel to agree or disagree with its content now.

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[1] Taken from *The Principles of Psychology*, I, pp. 619–27. New York: Henry Holt & Co., 1890.

It takes but a small exertion of introspection to show that the latter alternative is the true one, and that *we can no more intuit a duration than we can intuit an extension, devoid of all sensible content.* Just as with closed eyes we perceive a dark visual field in which a curdling play of obscurest luminosity is always going on; so, be we never so abstracted from distinct outward impressions, we are always inwardly immersed in what Wundt has somewhere called the twilight of our general consciousness. Our heart-beats, our breathing, the pulses of our attention, fragments of words or sentences that pass through our imagination, are what people this dim habitat. Now, all these processes are rhythmical, and are apprehended by us, as they occur, in their totality; the breathing and pulses of attention, as coherent successions, each with its rise and fall; the heart-beats similarly, only relatively far more brief; the words not separately, but in connected groups. In short, empty our minds as we may, some form of *changing process* remains for us to feel, and cannot be expelled. And along with the sense of the process and its rhythm goes the sense of the length of time it lasts. Awareness of *change* is thus the condition on which our perception of time's flow depends; but there exists no reason to suppose that empty time's own changes are sufficient for the awareness of change to be aroused. The change must be of some concrete sort—an outward or inward sensible series, or a process of attention or volition.

And here again we have an analogy with space. The earliest form of distinct space-perception is undoubtedly that of a movement over some one of our sensitive surfaces, and this movement is originally given as a simple whole of feeling, and is only decomposed into its elements—successive positions successively occupied by the moving body—when our education in discrimination is much advanced. But a movement is a change, a process; so we see that in the time-world and the space-world alike the first known things are not elements, but combinations, not separate units, but wholes already formed. The condition of *being* of the wholes may be the elements; but the condition of our *knowing* the elements is our having already felt the wholes as wholes.

In the experience of watching empty time flow—'empty' to be taken hereafter in the relative sense just set forth—we tell it off in pulses. We say "now! now! now!" or we count "more! more! more!" as we feel it bud. This composition out of units of duration is called the law of time's *discrete flow.* The discreteness is, however, merely due to the fact that our successive acts of *recognition* or *apperception* of *what* it is are discrete. The sensation is as continuous as any sensation can be. All continuous sensations are *named* in beats. We notice that a certain finite 'more' of them is passing or already past. To adopt Hodgson's image, the sensation is the measuring-tape, the perception the dividing-engine which stamps its length. As we listen to a steady sound, we *take* it *in* in discrete pulses of recognition, calling it successively 'the same! the same! the same!' The case stands no otherwise with time.

After a small number of beats our impression of the amount we have told off becomes quite vague. Our only way of knowing it accurately is by counting, or noticing the clock, or through some other symbolic conception. When the times exceed hours or days, the conception is absolutely symbolic. We think of the amount we mean either solely as a *name*, or by running over a few salient *dates* therein, with no pretence of imagining the full durations that lie between them. No one has anything like a *perception* of the greater length of the time between now and the first century than of that between now and the tenth. To an historian, it is true, the longer interval will suggest a host of additional dates and events, and so appear a more *multitudinous* thing. And for the same reason most people will think they directly perceive the length of the past fortnight to exceed that of the past week. But there is properly no comparative time *intuition* in these cases at all. It is but dates and events, *representing* time; their abundance *symbolizing* its length. I am sure that this is so, even where the times compared are no more than an hour or so in length. It is the same with Spaces of many miles, which we always compared with each other by the numbers which measure them.

From this we pass naturally to speak of certain familiar variations in our estimation of lengths of time. *In general, a time filled with varied and interesting experiences seems short in passing, but long as we look back. On the other hand, a tract of time empty of experiences seems long in passing, but in retrospect short.* A week of travel and sight-seeing may subtend an angle more like three weeks in the memory; and a month of sickness hardly yields more memories than a day. The length in retrospect depends obviously on the multitudinousness of the memories which the time affords. Many objects, events, changes, many subdivisions, immediately widen the view as we look back. Emptiness, monotony, familiarity, make it shrivel up. In Van Holtei's 'Vagabonds' one Anton is described as revisiting his native village.

> "Seven years," he exclaims, "seven years since I ran away! More like seventy it seems, so much has happened. I cannot think of it all without becoming dizzy—at any rate not now. And yet again, when I look at the village, at the church-tower, it seems as if I could hardly have been seven days away."

Prof. Lazarus (from whom I borrow this quotation), thus explains both of these contrasted illusions by our principle of the awakened memories being multitudinous or few:

> The circle of experiences, widely extended, rich in variety, which he had in view on the day of his leaving the village rises now in his mind as its image lies before him. And with it—in rapid succession and violent motion, not in chronologic order, or from chronologic motives, but suggesting each other by all sorts of connections—arise massive images of all his rich vagabondage and roving life. They roll and wave confusedly together, first perhaps one from the first year, then from the sixth, soon from the second, again from the fifth, the first, etc., until it seems as if seventy years must have been there, and he reels with the fulness of his vision. . . . . Then the inner eye turns away from all this past. The outer one turns to the village, especially to the church-tower. The sight of it calls back the old sight of it, so that the consciousness is filled with that alone, or almost alone. The one vision compares itself with the other, and looks so near, so unchanged, that it seems as if only a week of time could have come between.

The same space of time seems shorter as we grow older—that is, the days, the months, and the years do so; whether the hours do so is doubtful, and the minutes and seconds to all appearance remain about the same.

> Whoever counts many lustra in his memory need only question himself to find that the last of these, the past five years, have sped much more quickly than the preceding periods of equal amount. Let any one remember his last eight or ten school years: it is the space of a century. Compare with them the last eight or ten years of life: it is the space of an hour.

So writes Prof. Paul Janet, and gives a solution which can hardly be said to diminish the mystery. There is a law, he says, by which the apparent length of an interval at a given epoch of a man's life is proportional to the total length of the life itself. A child of 10 feels a year as 1/10 of his whole life—a man of 50 as 1/50, the whole life meanwhile apparently preserving a constant length. This formula roughly expresses the phenomena, it is true, but cannot possibly be an elementary psychic law; and it is certain that, in great part at least, the foreshortening of the years as we grow older is due to the monotony of memory's content, and the consequent simplification of the backward-glancing view. In youth we may have an absolutely new experience, subjective or objective, every hour of the day. Apprehension is vivid, retentiveness strong, and our recollections of that time, like those of a time spent in rapid and interesting travel, are of something intricate, multitudinous, and long-drawn-out. But as each passing year converts some of this experience into automatic routine which we hardly note at all, the days and the weeks smooth themselves out in recollection of contentless units, and the years grow hollow and collapse.

So much for the apparent shortening of tracts of time in *retrospect*. They shorten in *passing* whenever we are so fully occupied with their content as not to note the actual time itself. A day full of excitement, with no pause, is said to pass 'ere we know it.' On the contrary, a day full of waiting, of unsatisfied desire for change, will seem a small eternity. *Taedium*, *ennui*, *Langweile*, *boredom*, are words for which, probably, every language known to man has its equivalent. It comes about whenever, from the relative emptiness of content of a tract of time, we grow attentive to the passage of the time itself. Expecting, and being ready for, a new impression to succeed; when it fails to come, we get an empty time instead of it; and such experiences, ceaselessly renewed, make us most formidably aware of the extent of the mere time itself. Close your eyes and simply wait to hear somebody tell you that a minute has elapsed. The full length of your leisure with it seems incredible. You engulf yourself into its bowels as into those of that interminable first week of an ocean voyage, and find yourself wondering that history can have overcome many such periods in its course. All because you attend so closely to the mere feeling of the time *per se*, and because your attention to that is susceptible of such fine-grained successive subdivision. The *odiousness* of the whole experience comes from its insipidity; for *stimulation* is the indispensable requisite for pleasure in an experience, and the feeling of bare time is the least stimulating experience we can have. The sensation of taedium is a *protest*, says Volkmann, against the entire present.

Exactly parallel variations occur in our consciousness of space. A road we walk back over, hoping to find at each step an object we have dropped, seems to us longer than when we walked over it the other way. A space we measure by pacing appears longer than one we traverse with no thought of its length. And in general an amount of space attended to in itself leaves with us more impression of spaciousness than one of which we only note the content.

I do not say that *everything* in these fluctuations of estimate can be accounted for by the time's content being crowded and interesting, or simple and tame. Both in the shortening of time by old age and in its lengthening by *ennui* some deeper cause *may* be at work. This cause can only be ascertained, if it exist, by finding out *why we perceive time at all.*

EXERCISES

1. Seat yourself comfortably, close your eyes, and see how closely you can come to estimating the passage of a two-minute period. Do not count or give yourself any other artificial aid in making the estimate. Try this experiment a number of times. Do your estimates become more or less accurate? After making each estimate jot down a list of the sensations, ideas, etc., that might have helped you in your judgment.
2. Rank the seasons, winter, spring, summer, and fall, according to their psychological duration. Explain why some seasons seem longer or shorter to you than others.

B[1]

BY JAMES SULLY

a) Apprehension of sound series.—While hearing gives us comparatively little knowledge of space, it yields a very exact perception of time-relations. By this is meant the approximately direct apprehension of the order of succession, and of the rapidity of succession or duration of sounds. Thus we perceive the sequence of, and estimate the interval between, two clicks of a clock, and the duration of a musical tone.

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[1] Adapted from *The Human Mind*, pp. 269–72. New York: D. Appleton & Co., 1892.

Since the impressions whose time-relations are thus apprehended actually succeed one another in time, it is obvious that our perception of succession, etc., implies a certain persistence of the succeeding impressions in a weaker form, so that they may co-exist and be related to one another in one unifying act of perception. Our so-called *perception* of time, as we shall see by-and-by, always involves at least a rudimentary process of retrospection and representation of impressions which are already past.

The newer experimental psychology has occupied itself much with measuring our sense or perception of time (Zeitsinn), and these experiments have been chiefly carried out in relation to auditory impressions. This line of inquiry has already yielded some curious and interesting results. A reference to some of the principal ones may well complete this brief account of the auditory time-perception.

First of all, then, these experiments have shown that the grasp of successive sounds in a time-perception, that is as a succession, has its limits. Thus the two sounds must be separated one from another by a certain interval. According to Exner, two successive clicks of a Savart's wheel are apprehended as successive when the interval is reduced to one five-hundredth of a second. At the other extreme we find that if the interval is increased to four seconds it becomes impossible to connect them as members of a series.

Again, a number of inquiries have been carried out into the range of this perception of succession, or serial integration of sound, that is, the number of impressions of sound that can be integrated into one series. It is found that this depends in part on the interval between two successive sounds, the most favourable one being from .3 to .18 seconds. Under these circumstances a series of eight or more sounds can be grouped as one series. If, however, as almost certainly happens, there takes place an involuntary rhythmical arrangement of the sounds, the whole series being compounded out of periodic sub-divisions, a much larger number can be thus integrated. According to one experimenter as many as forty sounds will be perceived as constituents of a single serial whole, provided they are thus rhythmically grouped in periodically recurring groups of eight or five.

b) **Measurement of time-interval between sounds.**—Lastly, reference may be made to the experimental inquiry how far we can measure the precise interval between two sounds, and how this power varies as the interval is lengthened or shortened. It seems to be ascertained that the measurement is most exact when the interval is a small one, this favoured interval varying, according to different observers, from about .4 to 1.25 seconds.

The aim of these last experiments is to get the subject to construct a second time-interval equal to a given standard one, and to compare the errors made as the interval is increased. In this way the point of nicest appreciation, or "the interval of least error," is ascertained. Below this point the interval is made too large, above it, too small. Later research tends to show, however, that beyond this interval of least error the exactness of perception periodically declines and rises again. The explanation of the facts is not quite clear. The researches of Münsterberg, however, make it probable that in estimating time-interval we use as psychical material the muscular sensations that accompany the attitude of attendant expectancy. These sensations involve the varying tension of the muscles generally, and more particularly the alternating phases of tension and relaxation of the respiratory muscles. The influence of these last is interestingly illustrated in the fact that the comparison of interval was much more exact where the beginning and end in each case synchronised with the same respiratory phase.

The nice appreciation of time-relations in the case of the ear is of great practical consequence. Thus it is evident that the rapid and easy apprehension of spoken language depends on an accurate perception of the order of succession of the sounds, and a ready combination of the members of a time-series in a single perception.

It is, however, in the perception of the rhythmic successions of verse and music that the ear's appreciation of time-relations shows itself at its best. The essential element in this experience is regular recurrence after a definite interval, or periodicity. Here an accurate measurement of time-interval becomes essential. What we mean by the appreciation of time in music includes the comparison of successive simple time-lengths, whether filled with sound, or empty intervals or pauses, as well as multiples of these. Thus in "common time" the ear recognises the equality of duration or time-interval of the units (the crotchets), and of the quadruple groups of these making up the bars. The full appreciation of rhythm in music, and measure in verse, implies, in addition to measurement of time-length or interval, a recognition of numerical relations. The ear notes the periodic recurrence of a particular number of sounds in the case of each musical bar, as of the three in triple time, and this recognition underlies the appreciation of the particular form of the movement. This perception of time is aided by the distribution of accent, the place of the accent serving to mark the division or boundary of the successive time-intervals. Similarly the appreciation of (modern) metre appears to rest on the recognition of a regular, periodic recurrence of sounds, and a particular numerical grouping of these, the characteristic time-relations being marked by the distribution of the accent.

EXERCISES

1. Enumerate some of the more important changes which make you aware of passing time (*a*) during a class hour, (*b*) during a day, (*c*) during a year.
2. Certain persons, it is said, can predetermine, the night before, the hour of the next morning's awakening. Can you explain how this is possible?

C[1]

BY JAMES BURT MINER

Primary rhythm has been taken to mean the regular succession of like events, while secondary rhythm brings in the factor of grouping among these events. We shall use rhythm only in the sense of rhythmic grouping. To the psychologist a series of sounds takes on a new interest as soon as they are heard in groups. The grouping to which I refer is a true rhythmic experience, something more than counting the sensations in groups. There is a feeling of the group together. The group is 'felt,' so to speak, rather than counted. Each group is experienced as a sort of whole, which is compared with other wholes. The groups have their limitations and, like other perceptions, they are accompanied by an affective tone. In artistic rhythms the grouping is embellished by ideational associates. In this discussion we are to treat of only the simplest feeling of rhythm and try to explain that. We seek the fundamental fact that is common to rhythm, whether it be experienced in poetry, music, movement, or in a mere succession of noises. This fundamental fact, which sets rhythm off from other impressions, is that the groups are felt as units. Meumann, who has written the classical German monograph on rhythm, expresses this as the 'Zusammenfassung der Eindrücke.' He says: "The subjective holding together of the impressions in a whole is inseparably bound up with the simplest cases of rhythmic perception." Bolton, in the first empirical study directed specifically toward rhythm, speaks of the sounds running together to form organic groups. He lays much stress on the group appearing as a unit. Squire speaks of the 'unitary character' of the group and of its 'unity for perception.' Titchener calls this 'the essential thing in the perception of rhythm. We recognize the factor clearly in the case of a series of like sounds at uniform intervals which are rhythmically experienced. Explanations of rhythm have been generally directed toward the unitary character of the group. It is to this factor that I shall especially attend.

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[1] Taken from "The Description and Explanation of Rhythm," *Psychological Review, Monograph Supplements*, V (1903–4), 1–3.

As soon as we recognize that rhythm brings into consciousness a group feeling or 'Zusammenfassung,' which is not present in the objective stimuli, we seek at once some conscious process on which this can rest. When the rhythm is experienced from an objectively uniform series, either the sensations themselves must become actually united in time or by real changes in them; or else they must appear united by reason of some other accompanying element in consciousness which adds the group feeling. This element would, as it were, provide the thread on which the sensations from the external stimuli are strung out in groups. I shall contend that the evidence points to this latter suggestion; that feeling the groups to be units is an illusion due to the presence of movement or strain sensations along with the sensations that are grouped; that these sensations arise from movement or tension started reflexly in the muscles by the external stimuli. These kinæsthetic sensations are interpreted as an apparent change in a uniform objective series. The groups appear to be separated either by a longer interval or by a regularly recurring accent or both. In any case a kinæsthetic sensation within the group gives us the uniting element for consciousness.

6. THE PERCEPTION OF SPACE

A. The Growth of Space Perception[1]

BY JAMES R. ANGELL

Growth of space perception.—Our adult cognition of space relations is generally so immediate and unreflective, the feeling for space values so compelling and seemingly inevitable, that we find it difficult to believe that these reactions are the results of a slow process of growth and learning. Nevertheless, this is unquestionably the fact. Babies evidently have no precise perceptions of space until they have acquired a considerable degree of motor control; and even then their appreciation of large expanses and distances is often ludicrously inexact. The child reaching in good faith for the moon is the stock illustration of this sort of thing. That we have no precise appreciation of visual space relations until experience has brought it to us is abundantly proven by the cases of persons born blind and successfully operated upon for the restoration of sight. Immediately after the operation such persons are almost wholly at a loss for accurate impressions of size, shape, or distance. After the hands have explored the objects seen, and the eyes have been allowed to pass freely to and fro over them, these spatial impressions gradually begin to emerge and take on definiteness. By the use of properly arranged lenses and prisms experiments of various kinds have been made on normal persons, showing that we can speedily accommodate ourselves to the most unusual inversions and distortions of our visual space. We can thus learn to react properly, although all the objects, as we see them, are upside down and turned about as regards their right and left relations. The new relations soon come to have the natural feeling of ordinary perceptions.

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[1] Taken from *Psychology* (4th ed.), pp. 175–78. (Revised.) New York: Henry Holt & Co., 1908.

These observations show very strikingly that our space perceptions are functions of experience and can be changed by changing the conditions of the experience. Moreover, it is easy to demonstrate that the space relations, as we perceive them by different senses, are far from homogeneous. Indeed, the impressions which we gain from the same sense are often far from being in agreement. Nevertheless, we feel our space relations to be objectively homogeneous, a result which could hardly come about under such circumstances of sensory disparity without the harmonising effects of experience. To illustrate—the edge of a card pressed gently upon the forearm will feel to the skin shorter than it looks. The same card, if the finger tip is allowed to run slowly along it, will feel longer than it looks. The disappointing disparity between the cavity of a tooth, as it feels to the tongue and appears to the eye or feels to the finger-tip, is a notorious instance of the same thing. The tongue and the finger-tip both give us *pressure* sensations. Yet they give a very different report of the same object. Similarly, objects seen upon the periphery of the retina appear smaller than when seen by the fovea; and often they undergo a certain distortion in form. That we should perceive, amid all these possible sources of confusion, a fairly stable and well-ordered space world betokens unmistakably the systematising effects of experience, controlled no doubt by the exigencies of our practical interests in effective orientation.

Part played by movement.—Even though we recognize the fact that experience brings order and precision and effectiveness into our space perceptions, the general manner by which these results are achieved is not yet clear; much less what factors are chiefly employed in their attainment. It requires only the most cursory examination to convince oneself that the all-important element in the building up and correlating with one another of our various spatial sensations is *movement*. In acquiring accurate touch perceptions, for instance, the fingertips and hands move over the object, grasp it now in this way and now in that, until a complex set of tactual impressions has been gained from it. Without such movement our touch perceptions are vague in the extreme. If we close our eyes and allow another person to put a series of small objects upon our outstretched hands we receive only the most indefinite impressions of form and size and texture. But allow us to manipulate the same objects in our fingers, and we can give a highly accurate account of them. Similarly, if we wish to compare visually the magnitude and contours of two objects, we must allow our eyes to move freely from one to the other. Indeed, reflection must assure us that the *vital meaning* of all space relations is simply a given amount and direction of movement. To pass toward the right means to make a certain kind of movement; to pass upward means to make another kind, etc. To be sure, we assign arbitrary measures to these relations, and we say an object is a *mile* away, or is a *foot* thick and six *inches* high. But the meaning to us of the mile, the foot, and the inch must always remain ultimately expressible in movement.

Were it possible to get at the exact stages in the process by which the child acquires its control over space relations, we should thus secure the most penetrating possible insight into our adult space perceptions. But as this is at present impracticable, we must content ourselves with an analysis of the factors which seem clearly involved in these adult conditions, without regard to their genetic features.

EXERCISE

1. Why do we not always perceive objectively equal magnitudes as equal according to different senses? How would you go about eliminating such disparities as Angell discusses?

B. Tactual Space

I. SENSITIVENESS OF THE SKIN TO SPACE DIFFERENCES[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

Sensitiveness of the skin.—It is a familiar observation that all parts of the skin are not equally sensitive. The method of determining the degree of sensitiveness, first employed by Weber, consists in finding the smallest distance at which the two points of a pair of compasses can be felt. The results in millimetres[1] are given in the following table:—

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[1] Adapted from *The Physiology of the Senses*, pp. 54–55. New York: Charles Scribner's Sons. Copyrighted, 1893.

Tip of tongue	1.1
Under surface of third phalanx of finger	2–2.3
Red part of the lip	4.5
Under surface of second phalanx of finger	4–4.5
Upper surface of third phalanx of finger	6.8
Tip of nose	6.8
Ball of thumb	6.5–7
Temples	22.6
Forehead	22.6
Back of head	27.1
Back of hand	31.6
Knee	36.1
Gluteal region	44.6
Centre of palm	8–9
Under surface of third phalanx of great toe	11.3
Upper surface of second phalanx of finger	11.3
Back	11.3
Eyelid	11.3
Under surface of lower third of forearm	15.0
Cheek	15.8
Forearm and leg	45.1
Neck	54.1
Back, opposite fifth dorsal vertebra	54.1
Upper arm, thigh, centre of back	67.1

Numerous investigations made since the time of Weber have shown considerable variations in different individuals. The method is employed by physicians in the diagnosis of nervous diseases affecting the sensitiveness of the skin. The general result of Weber's method is to show that in a healthy person those parts are most sensitive as regards the power of discriminating two points at a certain distance from each other, which we use habitually as organs of touch. Thus the tips of the fingers on their under surface, the palms of the hands, the margins of the lips, are more sensitive than the dorsal surfaces of the limbs or the skin covering the back. Sensitiveness is great in parts of the body that are habitually moved, and it increases from the joints towards the extremities. Again, sensitiveness is finer if we proceed a given distance along the transverse axis of a limb than if we pass the same distance along the long axis.

II. The Perception of Locality of Touch[2]

BY EDWARD BRADFORD TITCHENER

Our visual perception of place or position is very highly organized; stimuli that are distinguished as spatially different, in daylight vision, are also definitely placed in relation to one another.[3] With the skin it is otherwise; the cutaneous perception of locality is less developed; and we are able, in the course of a single experiment, to bring out various modes and degrees of localisation. Suppose, for instance, that a pair of compasses, having delicately rounded points of hard rubber, is set down upon the skin of the forearm, with the points 1 mm. apart. We perceive, with eyes closed, a single, sharp pressure upon the forearm. Localisation may be effected in several ways: we may feel an impulse to move the hand of the opposite side towards the part touched, or we may have a visual picture of the arm and of the point resting upon it, or the pressure may touch off at once some form of words ("Halfway up the arm, in the middle"). The visual picture and the words are, of course, secondary criteria of cutaneous position, and the feel of the localising movement, though much more nearly primitive, is also in the last resort of secondary character. Here, then, is what we may call the absolute perception of cutaneous locality, the perception of the position of a single pressure. Now let us consider the relative perception: let the compass points be gradually separated, by small steps, and let us note the results. We get, first of all, a larger, blunt point; this gradually passes into a small surface of oval form: then comes a thickish line; then the perception of two sharp points, with a faint linear connection between them; and then the two points stand out separate and distinct. But all this while there has been no perception of the direction in which the lines or points lie; not, perhaps, till the compass-points are 25 mm. apart, can the observer say "longitudinal" or "transverse." Our perception begins as that of an absolutely localised, undifferentiated, cutaneous expanse; the expanse presently shows relative spatial difference, but a difference that cannot be expressed in terms of direction; next appears the indefinite perception of spatial duality, of two disconnected extents; and, finally, the relation of these extents becomes definite, and the perception of relative or directional position is complete.

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[1] 1 millimetre = 1/25 of an inch.

[2] Adapted by permission from *A Text-Book of Psychology*, pp. 321–23. New York: Macmillan Co. Copyrighted, 1910.

[3] This statement is true as a first approximation to the facts. We ought, by rights, to take account of indirect as well as of direct vision, of vision of luminous points in the dark as well as of vision in the daylight, of pathological states of the

EXERCISES

1. The blind are frequently very accurate in making localizations by means of touch. Their touch-sense organs are often, however, not any more sensitive than those of seeing people. How would you account for this?
2. Why do you think that the capacity to distinguish two points as two rather than one is more primitive than the capacity to perceive their relationship in terms of direction?

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retina, of the action of the ocular muscles in normal and abnormal conditions, of the position of the head. But if all the details were discussed, the psychology of space-perception would require a large book to itself.

C. Visual Space

I. Estimation of Size[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

The estimation of size depends on the size of the retinal image, or, in other words, of the *visual angle* subtended by the object. In Fig. 51, *X* is the visual angle subtended by the lines, *c*, *d*, and *e*, and since these objects make a retinal image of the same size it is evident that, in estimating size, it is necessary to have at least an approximate idea of the distance of the object from the eye. The moon subtends a larger visual angle than the stars because it is so much nearer to us, not because of its greater size.

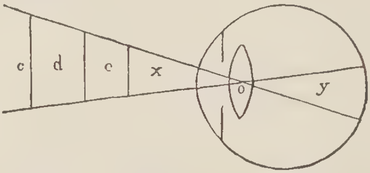

FIG. 51.—Visual angles. The objects *c*, *d*, *e*, though of different sizes, subtend the same visual angle, being at different distances from the eye.

We learn by experience, more especially by the combination of touch and vision, that if two objects of different sizes subtend the same visual angle, the nearer of the two is the smaller; and the young artist measures the comparative length and breadth of distant objects by holding his pencil at arm's length between his eye and the thing sketched.

The *degree of convergence of the visual axes* is also of much importance in the estimation of size. For by experience we know that an object of known size will subtend a certain *visual angle* at a given distance, and that the nearer the object is to the eye the greater will be the angle subtended, as in Fig. 52. Then, of all bodies which subtend the *same* visual angle, that one must be the largest which requires the least convergence.

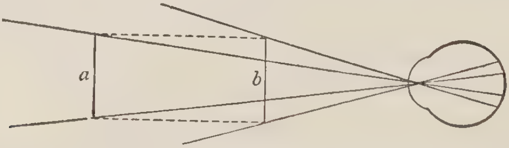

FIG. 52.—*a* and *b* are of the same length, but *b* subtends a greater visual angle, being nearer to the eye.

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[1] Adapted from *The Physiology of the Senses*, pp. 190–92. New York: Charles Scribner's Sons, 1893.

Thus, too, the intervention of bodies of known size gives an idea as to the size of the more remote object. The sun seen on the horizon behind trees seems larger than when in mid-heaven, because we have a better estimate of its distance and of the visual angle it should thus subtend. Few people agree in their estimate of the apparent diameter of the full moon, and in Fig. 53, B seems to have the greatest height from a mental summation of the horizontal spaces, *A* the greatest breadth, and *C* to be the smallest. Yet all are of the same area. In this case the three figures are of the same size, and must give rise to retinal images of the same size, but the basis on which we form our judgment as to the area of each being different, we judge them of different size. The judgment errs, not the organs of vision.

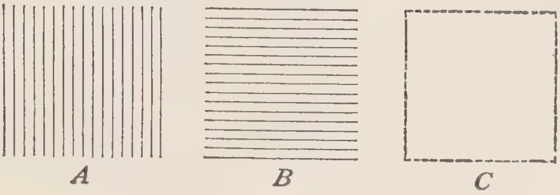

FIG. 53

II. HOW AN OBJECT IS SEEN AS ONE WITH TWO EYES[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

When we look at an object in the far distance the antero-posterior axes of the eyes are parallel, and an image of the object will be formed upon the spot of distinct vision in each eye. Again, when the object viewed is near at hand, the visual axes converge, so that the image is still formed upon the yellow spot of both eyes, and the object is seen as single. This sensation of oneness arises from the habitual use of these areas of the retinae for the observation of one and the same point, and from the attention given to that point alone as distinguished from all others in the visual field. But if we displace one of the visual axes by pressing with the finger upon the corresponding eye we will seem to see all objects doubled, one image being stationary, the other moving as we vary the pressure. The reason for this is as follows: under ordinary circumstances the mind projects the image formed in the eye outwards in the direction of the visual axis, and this being now mechanically displaced the object seems to be in motion.

[1] Taken from *op. cit.*, pp. 175–76.

But, further, since the whole field of normal vision seems single when seen with both eyes, it follows that the retinae, as a whole, act in combination, and give a single image of that which is focussed upon them. Now, suppose we hold two pencils upright in the middle plane of the body, but at different distances, we can voluntarily fix our attention upon one or other, and the one upon which we concentrate our regard will appear single, while the other will be indistinctly seen and will seem double. The image of that one to which we specially attend is single because the visual axes converge upon it, but the other is indistinct and double because its images on the two retinae are not in the line of regard, and not upon points which habitually act together.

III. Binocular Rivalry[1]

BY BURTIS BURR BREESE

If corresponding points of the two retinae are separately stimulated with two incongruous fields—*i.e.*, fields of sufficient difference to prevent their interpretation as a single field—the phenomenon of binocular rivalry appears. For a time one field presses itself into consciousness, then the other takes its place. In this manner a continual shifting of the fields takes place. If a green glass is held before one eye and a red glass before the other, and the eyes turned toward the sky, the struggle of colors is very readily seen. A simple way of getting rivalry between the two eyes is to close both eyes, cover one of them with the hand and turn the face toward the bright sky. The dark and the light fields will be seen alternately.

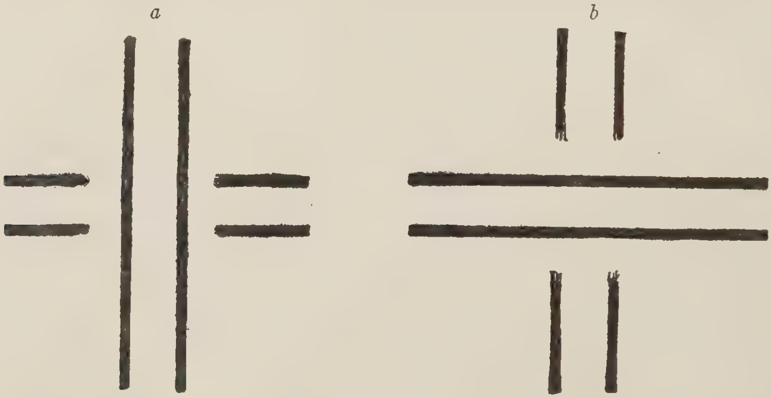

Fig. 54

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[1] Taken from "On Inhibition," *Psychological Review, Monograph Supplements*, III (1899), 18.

The stereoscope affords a convenient means of separating the two fields. If a simple drawing of two perpendicular parallel lines is so placed in the stereoscope that it can be seen by the right eye only, and another drawing of two horizontal parallel lines is placed so that it can be seen by the left eye alone, the cross which results shows at the point of intersection a rivalry of the two sets of lines. For an instant they will appear as in *a*, Fig. 54. The next instant they will appear as in *b*, same figure. The fluctuations will continue indefinitely.

IV. A CASE OF VISION ACQUIRED IN ADULT LIFE[1]

BY JAMES BURT MINER

The present Iowa case, moreover, seems to be the first attempt to utilize the modern laboratory equipment for testing systematically and quantitatively the senses and the learning process of a blind person who has been made to see. The young woman here reported was blind from birth by reason of complete cataracts in both eyes. She was operated on when she was 22 years of age.

In order that there may be no misunderstanding, it should be stated that persons having complete cataracts can distinguish light and darkness. In the opinion of Dr. Ware, who reported two cases to the Royal Society of England, patients with cataracts "are never so totally deprived of sight as to be unable to distinguish colors." In the famous Chesselden case the boy could distinguish scarlet previous to the operation. These individuals are "blind" in the popular and medical acceptation of the word; they make no use of their eyes in their daily work.

Besides testing Miss W.'s senses of vision, hearing, and touch, the main effort has been to study the process by which she learns to interpret what she sees. Undoubtedly the most fascinating work along this line was in connection with the development of binocular vision. It is a prevalent belief among physicians that the ability to see objects single when using both eyes must be acquired early in life or not at all. It has been suggested that the necessary association paths in the brain cannot be developed in adult life. The oculists point to many cases where a condition of crossed eyes has been corrected in adults, by operations on the eye muscles, and yet single binocular vision has not been attained. In such cases the individual neglects the image of one eye. Miss W. was in much the same condition as any cross-eyed person, except that she had used her eyes for only two years. Some idea of the progress which was made in the few weeks during which she was at the laboratory may be gathered from the following incidents.

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[1] Adapted from "A Case of Vision Acquired in Adult Life," *Psychological Review, Monograph Supplements*, VI (1905), 103–13.

While she was still naïve on this subject, I asked her to look through two small tubes, one held before each eye in such a manner that, if she desired, she could look with both eyes at the same object without moving the tubes. Under these conditions and looking at a single cone standing on the table, she said: "I see two cones, one with the right eye and the other with the left." She was quite emphatic about seeing two cones on the table. This was undoubtedly the usual way in which she interpreted the images from her two retinas.

The same effect was obtained in even a more striking way when Miss W. was provided with spectacles having differently colored glasses. Asked to describe how a large white surface appeared through the spectacles, she said: "Why, I see a large sheet of red cardboard with my right eye and a sheet of green cardboard with my left eye. They are both in the same place, and I am just as sure that I see them both at the same time as I am that I am standing here." When carefully questioned if one card was not seen after the other or behind the other, or if one part of the surface was not red and the rest green, she persisted in her first statement. She said that she could not understand how there could be two different surfaces in the same place at once but that was the way she saw them. Under the most careful experiments with gelatines of unknown color before her eyes and instantaneous exposures by an electric spark (conditions under which others in the laboratory were able to see but one color, on account of the tendency to retinal rivalry), Miss W. still maintained her perception of two surfaces of full size and of different colors, not overlying each other in any way.

If the psychologist should say that probably Miss W. did see two surfaces in the same place at the same time, we might be somewhat confounded by the mathematical axiom. However, it seems to me that we are forced to admit that she really did see two things in the same place at the same time. Furthermore, I am inclined to think that this may be the usual impression in childhood under like conditions. Moreover, there may be two moons for the child. Our later interpretation of what we see is a matter of education. We learn, of course, that there are not two objects, so we neglect the doubling of our eyes; or we disregard the image of one eye thus developing our phenomenon of retinal rivalry. It is possible that this rivalry of retinal images arises somewhat late in the child's life, and is only gained after the visual experience is tested by touch. From a subjective point of view, we may be quite confident that, for Miss W. at least, two differently colored surfaces were seen in the same place at the same time, and, also, that she naïvely believed that she saw two cones when there was only one.

V. The Perception of Solidity[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

When we look at a solid body the images formed in the two eyes are not exactly the same, because the right and left eyes view it from different standpoints. This can be best appreciated by viewing some small object at no great distance from the eye, *e.g.* a book. If we alternately examine the book with the right and left eye, the other being meanwhile closed, and compare mentally the appearances presented to the two eyes, we observe that the right eye sees more of the right side of the book, the left more of the left. If we then note what area of background is hidden by the two images, we find that the part hidden from the right eye by the book is different from that for the left. Now, with both eyes open, let vision be accommodated for the background, but examine the effect produced by the interposition of the book. We are then conscious of a solid opaque body obscuring part of the background completely, while to either side of this is a spectral transparent image of the sides of the book through which the wall seems to be seen. On shutting the left eye the solid body seems to move to the left, rendering the left spectral part opaque, because the part of the wall formerly seen by the left eye is no longer visible, and similarly for the right. It will further be noted, as we converge the eyes on the book, that the spectral parts disappear, and we see the one solid body only.

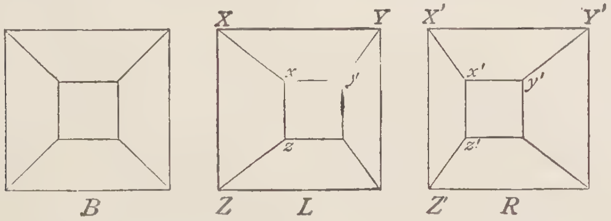

FIG. 55.—Appearance of a trunkated pyramid seen from above with *B*, both eyes, *L*, left eye, or *R*, right eye.

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[1] Taken from *op. cit.*, pp. 180–81.

Lastly, if we look at the book fixedly for some time, one eye being shut, and then if we look with both eyes, it is at once seen that the book stands out in much bolder relief, the various sides and borders taking their natural inclination in reference to space. A suitable object for the study of this phenomenon is a truncated pyramid upon which we look vertically downward. With both eyes open the appearance presented is that seen in *B* (Fig. 55). Keeping the head in the same position, but looking with the left eye only, we will see the pyramid as in *L*, or with the right eye only, as in *R*.

VI. THE STEREOSCOPE[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

The combination of Left and Right, so as to present the appearance of solidity to the eye, may be made by the *stereoscope*, an instrument invented by Wheatstone, who first noticed that the perception of solidity was due to the dissimilarity of the images presented to the retinae. In its simplest form the reflecting stereoscope consists of two mirrors placed at right angles to each other, as in Fig. 56. The eyes, looking into these obliquely, see reflections of the dissimilar figures *R* and *L* representing the appearances as seen by each eye individually; and the images, mentally projected backwards in the line of vision, are combined at the point of intersection of the optic axes, and we seem to see the single solid object as we would if we were looking at it with both eyes.

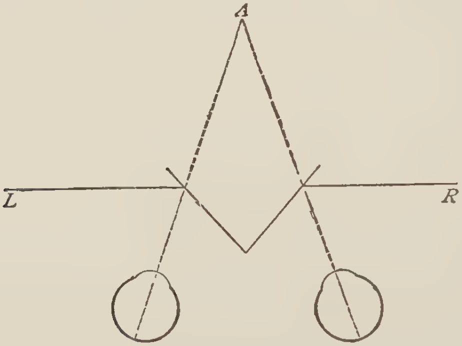

FIG. 56.—Wheatstone's stereoscope

Brewster's refracting stereoscope is the one in common use. In this instrument the optical effect is obtained by means of two lenses so arranged that rays of light passing from the stereoscopic pictures impinge on the retina, and are projected backwards so as to converge and meet at points behind the plane of the pictures, as in Fig. 57. Each eye thus sees its own picture, but corresponding points are brought to a focus, and in the union of all we have one picture in relief.

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[1] Adapted from *op. cit.*, pp. 181–82.

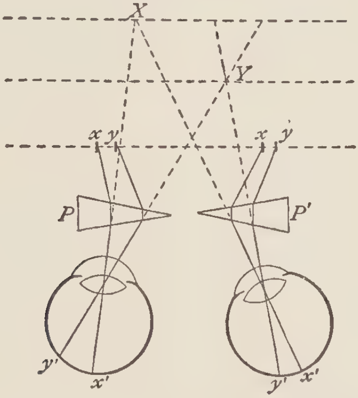

FIG. 57.—Diagram illustrating the principle of Brewster's stereoscoper. The points x, x forming images x', x' are projected outward and coincide at X; the points y, y, being nearer to one another than x, x, appear to coincide at a point Y in a plane nearer to the eyes than X. (After Landois and Stirling.)

VII. ESTIMATION OF DISTANCE[1]

BY JOHN G. M'KENDRICK AND WILLIAM SNODGRASS

The foregoing considerations on the perception of solidity will assist us in answering the more general question as to the estimation of *space or distance.* We have seen that the muscular effort at convergence is greater for near than for remote objects, and the greater the effort experienced the nearer do we judge the object to be. But accompanying the effort at convergence there is usually a muscular action of accommodation. The pupil contracts to shut off divergent rays of light which would cause blurring of the image, and the ciliary muscle contracts in order to lengthen the focal distance of the eye for the nearer object. Each of these muscular efforts must add its quantum to the general sum of muscular sensation. Objects at the point of sight are seen in clear detail, while those which are nearer or farther off are seen indistinctly, and we unconsciously judge of differing distances by varying efforts of accommodation. The dimness of bodies within the near point of vision is due to the impossibility of focussing the object. Far-distant objects are dimly seen because of the aerial perspective. The atmosphere not being perfectly transparent and colourless, small details are blotted out, and variety of colour lost in a bluish haze. The distant parts of a landscape are conceived to be nearer and smaller when seen in wet weather than in dry, for dust-laden air gives a more marked aerial perspective than that which has been washed by rain; and again, in misty weather the half-hidden forms of men may seem far away and of supernatural size.

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[1] Taken from *op. cit.*, pp. 187–90.

Again, varying convergence assists our estimation of distance, not only through the muscular effort involved, but also by variation of the *angle of convergence* of the visual axes upon the object. For objects of similar size it is evident that the angle of convergence must be greater for near than for remote objects. We learn through the other senses, as well as through sight, to know the comparative sizes of objects, and by noting and comparing the apparent size of objects we arrive at a judgment as to their distance, the seemingly smaller, of course, being considered the more distant. Persons who have lost the use of one eye, and therefore the valuable aid of convergence, cannot judge accurately of the distance of near objects. If asked to touch an object quickly they are apt to fall short, as experience tells them they may misjudge and strike it roughly if they attempt to reach the full apparent distance.

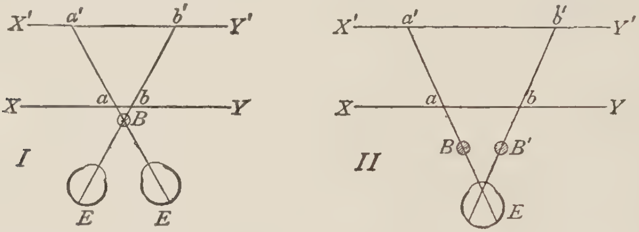

FIG. 58.—Estimation of distance from change in relative position of the eye and of an object observed.

Estimation of distance is likewise assisted by observation of the distance of the background over which a body near to the eye seems to move when the relative positions of the eye and the body are changed.

In Fig. 58, *I*, the eye *E* moves while the body *B* is stationary, in *II* the body moves from *B* to *B′* while the eye is stationary. The apparent distance moved by *B* upon *XY* is only *ab*, while upon *X′Y′* it is the much larger distance *a′b′*. The distance over which the body seems to pass gives an indication of the relative distances of the planes XY, $X'Y'$ from the observer.

We are also able to give a more accurate estimate of the distance between two points when several objects intervene. We take a series of mental leaps, as it were, from point to point, the effort of which is greater than that of passing-over the whole distance at one effort. The distance between A and B (Fig. 59) seems greater than that between B and C on account of the intervening dots, but it is the same. Children often amuse themselves with the following experiment. A boy, after looking at a landscape in an erect posture, will turn, stoop down, and view it between his legs, and all objects will seem farther off, as, from the unaccustomed posture and the proximity of the head to the ground, objects in the foreground, formerly disregarded, are now more dwelt upon. Similarly, the sky seems nearer us at the zenith than at the horizon, and a landsman has great difficulty of judging distances at sea. The eye projects the image of the object viewed outwards, but if it be at any great distance, the lines of projection from the two eyes are practically parallel, and judgments as to size guide the judgment as to distance. It is interesting to note, in this regard, that persons who have been born blind and have by an operation gained the power of vision, seem at first to see all objects close to the eye or almost touching it—they "see men as trees walking"—and it is only after a process of education in which the sense of touch has much to do that they are able to form a proper estimate of externality or distance through vision.

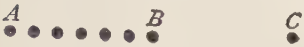

Fig. 59

VIII. Some Illusions of Visual Space[1]

a) The Apparent Size of the Sun and Moon

BY CHARLES S. MYERS

The causes of the apparent increase in size of the sun and moon at the horizon have been the subject of much controversy. The illusion varies widely in different individuals, and from time to time in the same individual. The enlargement suddenly becomes much greater in the immediate vicinity of the horizon.

The usually given explanation is that we judge the sun and moon to be more distant at the horizon than at the zenith, and that therefore we infer that they are larger at the horizon. It is supposed that one reason for the apparently greater distance of the sun and moon at the horizon lies in the atmospheric haze near the earth's surface, which especially affects the distinctness and colour of the sun and moon in that position; and that another reason lies in the number of terrestrial objects intervening between the observer and the sun or moon at the horizon, thus providing a filled distance which seems longer than the equal unfilled distance between the observer and the sun or moon when it is at the zenith. It has also been thought that the absence of other objects at the zenith, with which the heavenly objects can be compared, accounts for the apparent difference in their size; whereas at the horizon the sun or moon comes to be regarded as one of the terrestrial objects. Other causes, *e.g.*, the size of the pupil and movements of the lens, have been also suggested. The first mentioned of all these factors is probably the most important, and some of the others may undoubtedly play a subsidiary part. It is wrong, however, to say that there results a judgment that the sun or moon is more distant at the horizon than at the zenith. As a matter of fact, in consequence of their enlargement at the horizon, the heavenly bodies appear to be not farther but nearer than at the zenith.

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[1] Taken by permission from *A Text-Book of Experimental Psychology* (2d ed.), Part I, pp. 292–94. New York: Longmans, Green & Co., 1911.

The illusion has been experimentally studied by using a mirror so as to reflect the sun or moon at the horizon to the zenith, or *vice versa;* and by regarding the moon at the zenith in a supine position and the moon at the horizon with the head inverted between the legs. The results, however, are so contradictory that they only show the need for further study of the many factors which enter into the illusion.

The greater muscular strain involved in looking upwards has also been advanced as an explanation. When the plane of regard is raised, the two eyes converge more and more, and this is supposed to give the effect of increased nearness or diminished size.

The form of the sky is unquestionably an important factor in the illusion. It usually appears to be not hemispherical, but flattened at the horizon. And it is this apparently greater distance of the sky and of celestial objects at the horizon which, although not actually recognised, yet affects an unconscious "schema," and this leads to an apparent enlargement of the heavenly objects where they rise or set.

The cause of this flattening of the sky at the horizon has been much debated. It has been referred to the presence of intervening objects on the earth's surface, to the results of changing the direction of gaze, and to the difference in coloration of the sky at the zenith and at the horizon, which is due to differences in transparency, density, and brightness of the state of air. Probably each of these is a determining factor.

b) Some Types of Geometrical Illusions[1]

BY M. LUCKIESH

The effect of the location in the visual field.—One of the most common illusions is found in the letter "S" or figure "8." Ordinarily we are not strongly conscious of a difference in the size of the upper and lower parts of these characters; however, if we invert them (8888 SSSS) the difference is seen to be large. The question arises, Is the difference due fundamentally to the locations of the two parts in the visual field? It scarcely seems credible that visual perception innately appraises the upper part larger than the lower, or the lower smaller than the upper part when these small characters are seen in their accustomed position. It appears to be possible that here we have examples of the effect of learning or experience and that our adaptive visual sense has become accustomed to overlook the actual difference. That is, for some reason through being confronted with this difference so many times, the intellect has become adapted to it and, therefore, has grown to ignore it. Regardless of the explanation, the illusion exists and this is the point of chief interest. For the same reason the curvature of the retina does not appear to account for illusion through distortion of the image, because the training due to experience has caused greater difficulties than this to disappear. We must not overlook the tremendous "corrective" influence of experience upon which visual perception for the adult is founded. If we have learned to "correct" in some cases, why not in all cases which we have encountered quite generally?

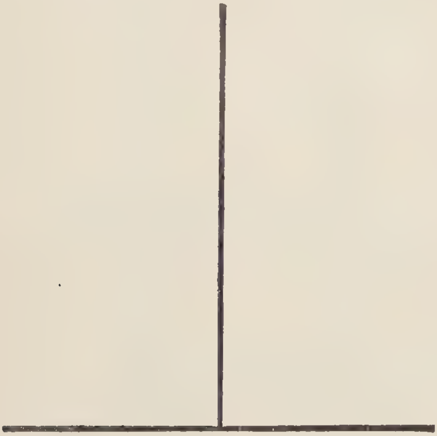

Fig. 60.—The vertical line appears longer than the equal horizontal line in each case.

This type of illusion persists in geometrical figures and may be found on every hand. A perfect square when viewed vertically appears too high, although the illusion does not appear to exist in the circle. In Fig. 60 the vertical line appears longer than the horizontal line of the same length. This may be readily demonstrated by the reader by means of a variety of figures. A striking case is found in Fig. 61, where the height and the width of the diagram of a silk hat are equal. Despite the actual equality the height appears to be much greater than the width. A pole or a tree is generally appraised as of greater length when it is standing than when it lies on the ground. This illusion may be demonstrated by placing a black dot an inch or so above another on a white paper. Now, at right angles to the original dot place another at a horizontal distance which appears equal to the vertical distance of the first dot above the original. On turning the paper through ninety degrees or by actual measurement, the extent of the illusion will become apparent. By doing this several times, using various distances, this type of illusion becomes convincing.

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[1] Adapted from *Visual Illusions*, pp. 44–63. New York: D. Van Nostrand Co., 1922.

The explanation accepted by some is that more effort is required to raise the eyes, or point of sight, through a certain vertical distance than through an equal horizontal distance. Perhaps we unconsciously appraise effort of this sort in terms of distance, but is it not logical to inquire why we have not through experience learned to sense the difference between the relation of effort to horizontal distance and that of effort to vertical distance through which the point of sight is moved? We are doing this continuously, so why do we not learn to distinguish; furthermore, we have overcome other great obstacles in developing our visual sense. In this complex field of physiological psychology questions are not only annoying, but often disruptive.

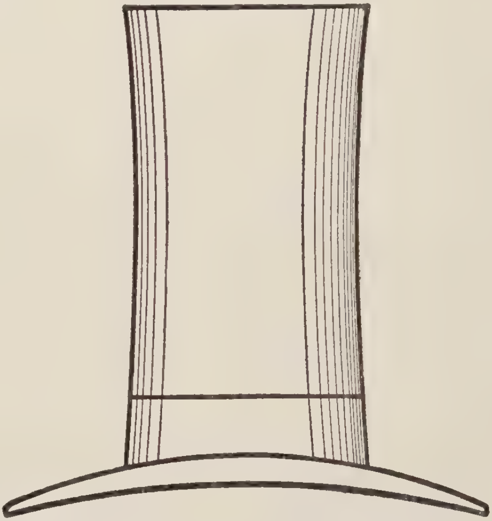

Fig. 61.—The vertical dimension is equal to the horizontal one, but the former appears greater.

Images of objects lying near the periphery of the visual field are more or less distorted, owing to the structure and to certain defects of parts of the eye. For example, a checkerboard viewed at a proper distance with respect to its size appears quite distorted in its outer regions.

Illusions of interrupted extent.—Distance and area appear to vary in extent, depending upon whether they are filled or empty or are only partially filled. For example, a series of dots will generally appear longer over all than an equal distance between two points. This may be easily demonstrated by arranging three dots in a straight line on paper, the two intervening spaces being of equal extent, say about one or two inches long. If in one of the spaces a series of a dozen dots is placed, this space will appear longer than the empty space. However, if only one dot is placed in the middle of one of the empty spaces, this space now is likely to appear of less extent than the empty space. (See Fig. 63.) A specific example of this type of illusion is shown in Fig. 62. The filled or divided space generally appears greater than the empty or undivided space, but certain qualifications of this statement are necessary. In *a* the divided space unquestionably appears greater than the empty space. Apparently the filled or empty space is more important than the amount of light which is received from the clear spaces, for a black line on white paper appears longer than a white space between two points separated a distance equal to the length of the black line. Furthermore, apparently the spacing which is the most obtrusive is most influential in causing the divided space to appear greater for *a* than for *b*. The illusion still persists in *c*.

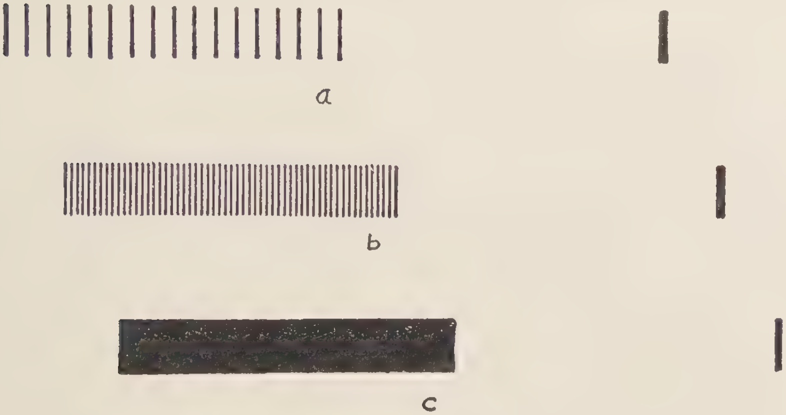

FIG. 62.—The divided or filled space on the left appears longer than the equal space on the right.

An idea of the magnitude may be gained from certain experiments by Aubert. He used a figure similar to *a*, Fig. 62, containing a total of five short lines. Four of them were equally spaced over a distance of 100 mm. corresponding to the left half of *a*, Fig. 62. The remaining line was placed at the extreme right and defined the limit of an empty space also 100 mm. long. In all cases, the length of the empty space appeared about ten per cent less than that of the space occupied by the four lines equally spaced. Various experimenters obtain different results, and it seems reasonable that the differences may be accounted for, partially at least, by different degrees of unconscious correction of the illusion. This emphasizes the desirability of using subjects for such experiments who have no knowledge pertaining to the illusion.

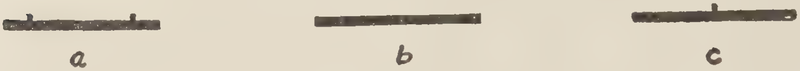

FIG. 63.—The three lines are of equal length

As already stated there are apparent exceptions to any simple rule, for, as in the case of dots cited in a preceding paragraph, the illusion depends upon the manner in which the division is made. For example, in Fig. 63, *a* and *c* are as likely to appear shorter than *b* as equal to it. It has been concluded by certain investigators that when subdivision of a line causes it to appear longer, the parts into which it is divided or some of them are likely to appear shorter than isolated lines of the same length. The reverse of this statement also appears to hold. For example in Fig. 63, *a* appears shorter than *b* and the central part appears lengthened, although the total line appears shortened. This illusion is intensified by leaving the central section blank. A figure of this sort can be readily drawn by the reader by using short straight lines in place of the circles in Fig. 64. In this figure the space between the inside edges of the two circles on the left appears larger than the overall distance between the outside edges of the two circles on the right, despite the fact that these distances are equal. It appears that mere intensity of retinal stimulation does not account for these illusions, but rather the figures which we see.

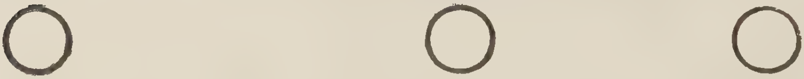

FIG. 64.—The distance between the two circles on the left is equal to the distance between the outside edges of the two circles on the right.

Illusions of contour.—The illusions of this type, or exhibiting this influence, are quite numerous. In Fig. 65 there are two semicircles, one closed by a diameter, the other unclosed. The latter appears somewhat flatter and of slightly greater radius than the closed one.

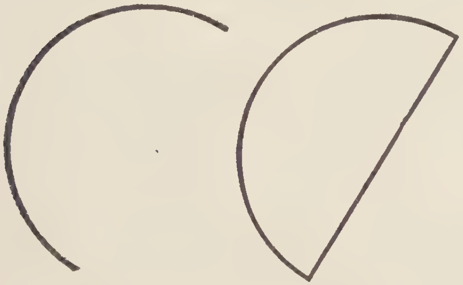

FIG. 65.—Two equal semicircles

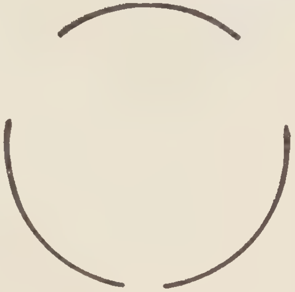

FIG. 66.—Arcs of the same circle

Similarly in Fig. 66 the shorter portion of the interrupted circumference of a circle appears flatter and of greater radius of curvature than the greater portions. In Fig. 67 the length of the middle space and of the open-sided squares are equal. In fact there are two uncompleted squares and an empty "square" between, the three of which are of equal dimensions. However the middle space appears slightly too high and narrow; the other two appear slightly too low and broad. These figures are related to the well-known Müller-Lyer illusion illustrated in Fig. 68.

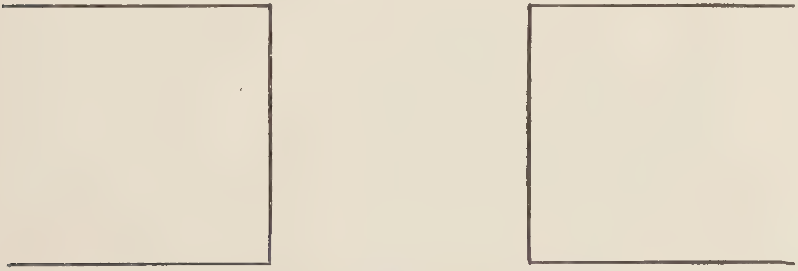

FIG. 67.—Three incomplete but equal squares

Illusions of contrast.—Those illusions due to brightness contrast are not included in this group, for "contrast" here refers to lines, angles and areas of different sizes. In general, parts adjacent to large extents appear smaller and those adjacent to small extents appear larger. A simple case is shown in Fig. 69, where the middle sections of the two lines are equal, but that of the shorter line appears longer than that of the longer line. In Fig. 70 the two parts of the connecting line are equal, but they do not appear so. This illusion is not as positive as the preceding one and, in fact, the position of the short vertical dividing line may appear to fluctuate considerably.

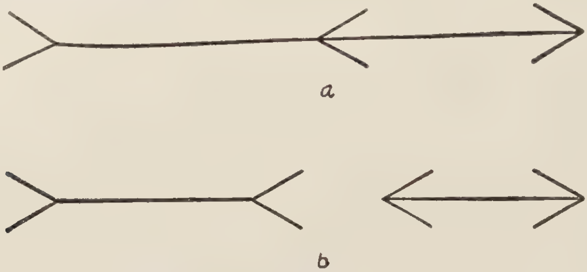

FIG. 68.—The Müller-Lyer illusion

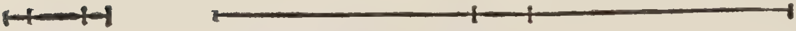

FIG. 69.—Middle sections of the two lines are equal

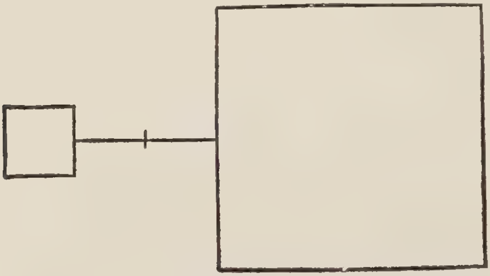

FIG. 70.—An effect of contrasting areas (Baldwin's figure)

In Fig. 71 are found examples of effects of lines contrasted as to length.

The reader may readily construct an extensive variety of illusions of contrast; in fact, contrast plays a part in most geometrical-optical illusions. The contrasts may be between existing lines, areas, etc., or the imagination may supply some of them.

Illusions of perspective.—As the complexity of figures is increased the number of possible illusions is multiplied. In perspective we have the influences of various factors such as lines, angles, and sometimes contour and contrast. In Fig. 72 the suggestion due to the perspective of the cube causes right angles to appear oblique and oblique angles to appear to be right angles. This figure is particularly illusive. It is interesting to note that even an after-image of a right-angle cross when projected upon a wall drawn in perspective in a painting will appear oblique.

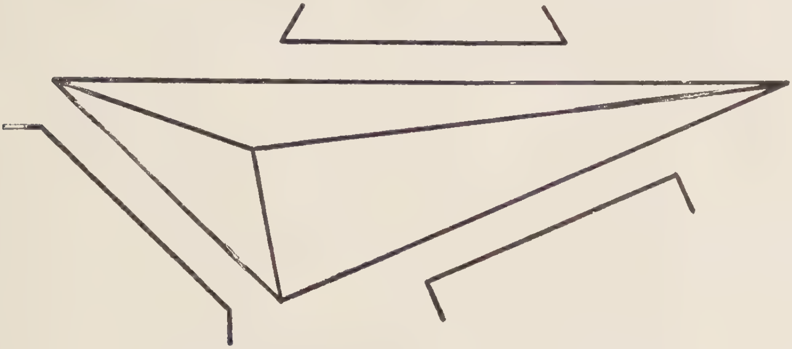

FIG. 71.—Combined influences of angles and contrasting lengths

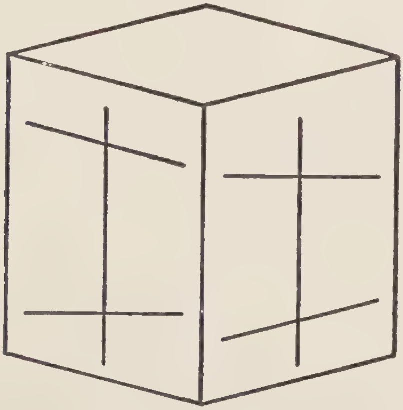

FIG. 72.—Owing to perspective the right angles appear oblique and vice versa

The effect of contrast is seen in *a* in Fig. 74; that is, the short parallel lines appear farther apart than the pair of long ones. By adding the oblique lines at the ends of the lower pair in *b*, these parallel lines now appear farther apart than the horizontal parallel lines of the small rectangle.

The influence of perspective is particularly apparent in Fig. 75. where natural perspective lines are drawn to suggest a scene. The square columns are of the same size but the farther one, for example, being apparently the most distant and of the same physical dimensions, actually appears much larger. Here is a case where experience, allowing for a diminution of size with increasing distance, actually causes the column on the right to appear larger than it really is. The artist will find this illusion even more striking if he draws three human

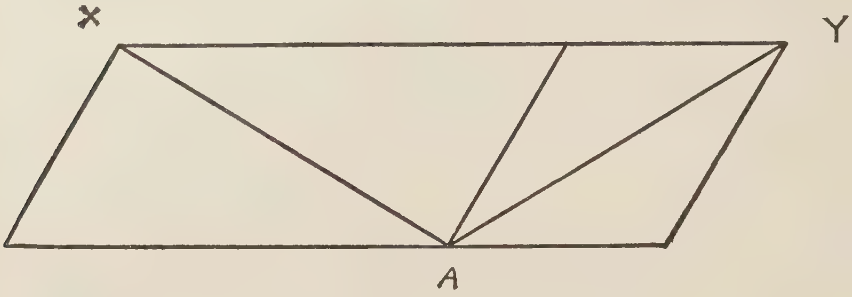

FIG. 73.—Two equal diagonals which appear unequal

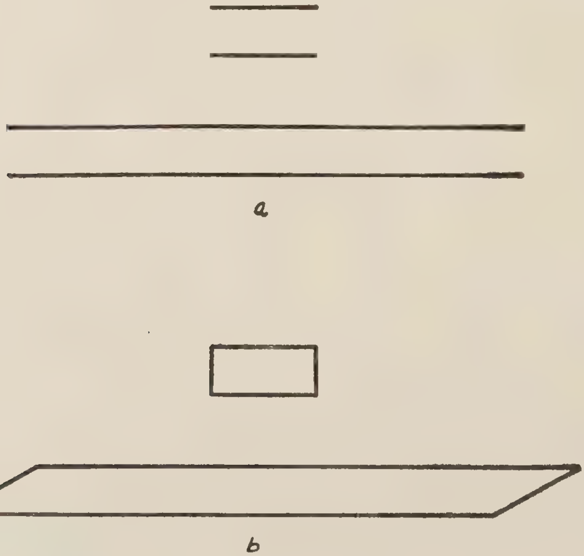

FIG. 74.—Apparent variations in the distance between two parallel lines

figures of the same size but similarly disposed in respect to perspective lines. Apparently converging lines influence these equal figures in proportion as they suggest perspective.

It is interesting to note that we are not particularly conscious of perspective, but it is seen that it has been a factor in the development of our visual perception. In proof of this we might recall the first time as children we were asked to draw a railroad track trailing off in the distance. Doubtless, most of us drew two parallel lines instead of converging ones. A person approaching us is not sensibly perceived to grow. He is more likely to be perceived all the time as of normal size. The finger held at some distance may more than cover the object such as a distant person, but the finger is not ordinarily perceived as larger than the person. Of course, when we think of it we are conscious of perspective and of the increase in size of an approaching

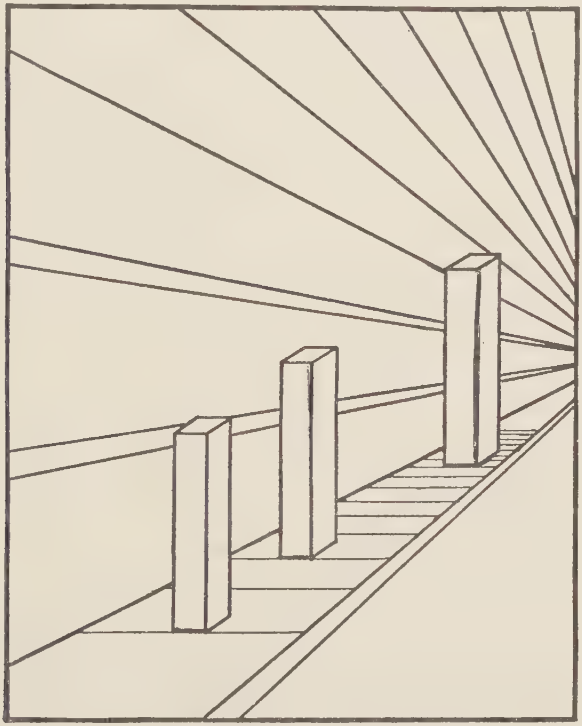

FIG. 75.—A striking illusion of perspective

object. When a locomotive or automobile approaches very rapidly, this "growth" is likely to be so striking as to be generally noticeable.

The foregoing are a few geometrical illusions of representative types. These are not all the types of illusions by any means and they are only a few of an almost numberless host. These have been presented in a brief classification in order that the reader might not be overwhelmed by the apparent chaos.

EXERCISES

1. Suppose that a man and a child are at such a distance from you that the visual angles subtended by the two are equal. Suppose, also, that the situation is one in which it is difficult or impossible to judge the relative distances between you and the man and between you and the child. Would you perceive them as of the same or different size? Why?
2. Would binocular fusion be necessary if the fields of view of the two eyes did not overlap? Defend your answer.
3. In taking stereoscopic pictures, two lenses are employed--one to take the right-eye view and the other the left-eye view. What difference will there be in the appearance of a number of stereoscopic pictures of the same object taken with the lenses at varying distances apart?
4. What do you think would be the result if the right and left pictures were interchanged?
5. Why is it that objects, such as people, observed from a tower or high building seem smaller than the same objects observed from the same distance but from a point on the earth's surface?

D. Auditory Localization[1]

BY HARVEY A. CARR

Intensity and tonal complexity are local signs of *distance*. Sounds are judged to be near in proportion to their apparent loudness and tonal complexity. Obviously these factors do vary with distance. The more removed the source of a sound wave, the less effectively will it stimulate the ear. Vibrating bodies emit a series of overtones of varying strength. When the object is close at hand, all the overtones stimulate the ear and a complex sound is heard. With greater distances, only the stronger partials are heard, and finally only the fundamental tone is audible. This fact accounts for the apparent change in the nature of a sound with distance. A locomotive whistle in the far distance is hollow, flat and sonorous because of the absence of overtones. When near at hand, the sound is shrill, harsh, rough and piercing on account of the presence of high and dissonant partials. The ventriloquist utilizes these principles in creating his distance illusions. The effectiveness of the two criteria may be easily demonstrated by experimental means. Two tuning forks of the same pitch are placed at an equal distance in front of a blindfolded subject. When these are sounded in succession with a noticeable difference in intensity, the louder of the two will be judged to be the nearer.

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[1] Taken from the manuscript of a textbook in psychology.

The student must not confuse the physical and the psychological principles involved. A person hears a sound as loud because of its nearness, but recognizes its near location because of its loudness. The first statement expresses a law of physics, and the second a law of psychology. One must not naïvely assume that these criteria of distance are utilized as a result of the subject's knowledge of the physical principles involved. As a matter of fact, most people are ignorant of their methods of estimating the distance of sounds, and these methods are developed in early childhood long before the attainment of any knowledge concerning the physics of sound.

The appreciation of the *direction* of sounds is based upon the *binaural ratio* of stimulation. When the two ears are stimulated by a vibrating body, the two auditory experiences are normally fused into a single sound. This fusion is lacking in certain abnormal conditions, and the subject hears double. When the object is located in the median plane of the head and hence at an equal distance from the two ears, naturally the two stimuli will be alike in intensity, tonal complexity, and phase. The term "similarity of phase" means that the two ears are affected coincidently by the condensation or rarefaction phases of the air wave. The ears are stimulated in the opposite phase when the period of rarefaction in one ear coincides with the period of condensation in the other. When the object is located to the right of the subject, the stimulus for the right ear will be the more intense and complex, and the two ears will be stimulated by different phases of the sound wave.

According to one experiment, the binaural-phase ratio may be utilized to some extent in recognizing the direction of sounds, but the results were not at all decisive. The effectiveness of intensity and tonal complexity, however, has been amply demonstrated. Blindfolded subjects with the left ear plugged consistently locate sounds to the right of their actual position. Persons afflicted with a partial deafness in one ear are at first unable to localize sounds with any degree of accuracy. The difficulty may be corrected in time by learning to associate each position in space with a new binaural ratio of stimulation. Whereas a person normally locates the sound in the median plane when the two ears are equally stimulated, he may learn, after becoming slightly deaf in the left ear, to associate equal stimulation with a position to the left. When two similar sounding bodies are placed in a symmetrical position in respect to the median plane of the head and are sounded simultaneously, only one sound will be heard. When the two objective stimuli are equal in intensity, the resultant sound will be located in the median plane. If the left object be sounded the more intensely, the sound will be located to the left. If two telephone receivers be used and the current be broken, the resultant click is frequently heard inside the head, being located in the back and upper part of the throat.

Certain monaural criteria may be utilized in judging direction. Subjects have been tested who have been pronounced by competent aurists to be totally deaf in one ear. Some ability to localize direction was manifested, and this ability improved with experience. The binaural factor has evidently been excluded in these cases. The results indicate that the monaural criteria are used but little in normal experience, but that a person can learn to rely upon them when the binaural factor is excluded. The tests indicated that the apparent intensity and tonal complexity of sounds were the factors involved in these judgments. With monaural deafness, it is apparent that a sound located on the side of the good ear will be a more effective stimulus than when placed in a corresponding position on the opposite side of the head.

Auditory localization at best is quite defective. By the use of the binaural factors, one can determine quite accurately whether the source of the sound is in the median plane or situated to the right or left, but an appreciation of positions within the median plane of the right and left hemispheres is extremely inaccurate. In normal experience, the deficiency of auditory localization is supplemented by other means. Head and body movements are employed for this purpose When a sound is located to the right but a more accurate definition of its direction is demanded, one can turn the head until the sound is heard in the median plane. Vision and memory are effective aids. The nature of the object is first identified from the character of the sound, and the object is then localized in terms of vision or by means of memory. One hears a voice of whose position he is uncertain. On the basis of its tonal character, the voice is recognized as that of a friend, and this person is then located with the aid of vision.

EXERCISES

1. What relationship would you expect between the distance of a source of sound and the accuracy with which it can be localized? Why?
2. What relationship would you expect between the purity of a tone and the accuracy with which it can be localized? Why?

7. THE PERCEPTION OF MOVEMENTS[1]

BY MADISON BENTLEY

The temptation to seek in "sensation" an explanation of the mysteries of experience appears again in the psychology of movement. Often writers have spoken of a "sensation of movement" and they have also based their descriptions upon that ambiguous phrase. But when we reflect that movement is usually a continuous modification of some spatial characteristic, we shall see that it is (at least in most cases) an aspect of apprehended objects—just as form, size, distance, and place are.

Take any spatial aspect of objects that you please and consider it as undergoing a gradual and fairly rapid change. There you have movement. The toy balloon inflated by gas (size) or indented by the finger (shape) or cut loose and carried away (distance) or blown about by the wind (direction) or passed from hand to hand (place). All of these gradual changes we apprehend as movement. There is no more a "sensation of movement" than there is a "sensation of place" or of "distance." We apprehend it just as we apprehend the other spatial attributes and relationships of objects. It has, however, one peculiarity which relates it to melody, rhythm and speech—a class of non-spatial perceptions. It is an *event*. Movement goes on. It is in progress. Many objects we regard as static. Not so movement, which happens.

Now what are the conditions adequate to the perception of movement? The unreflective answer of common sense is "some object in motion." But a moment's scrutiny of a moving sign above the street will convince any one that this answer is wrong; or at least that motion in the stimulus is not necessary to the perception. A half-dozen electric lamps set closely in a row and lighted in rapid succession will give rise to light "running along," and the movement will become still more continuous and fluent when the lights are inclosed behind a long ground-glass screen. The electric bird which flaps its wings, the electric arm which strikes, the electric fan which opens and closes above the theater, the electric mannikin that dances, are all light-patterns which fade and glow in rapid succession. The objects do not themselves move. This creation of moving objects without change of place in the stimulus makes possible the moving picture, where the photographic film stops before the lantern-light is projected on the screen, and passes on to give place to another, slightly different, momentary exposure. Another familiar experience which shows that the shift of objects along the skin or of light over the retina is not the real condition of the perception of movement is the passing of the hand over objects upon the table or the roving of the eyes over the landscape. In spite of the continuous shift in stimulation in these cases, the objects explored are apprehended as themselves at rest. But it is a curious fact that when the eyeball is displaced from the side by the finger tips or from the brain in dizziness (as after rotation), then objects are seen in motion although we "know" that they are standing still.

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[1] Taken from *The Field of Psychology*, pp. 231–34. New York: D. Appleton & Co., 1924.

A good deal of mystery has been made of the perception of movement. Most psychologists virtually admit that the mystery is inscrutable by declaring that the perception is native to the organism, that the individual is born with a capacity for apprehending movement; so they have recourse to a nativistic or genetic theory.[1] The fundamental fact underlying this perception is the wholeness of the perceptual field. It is continuous for any size and dimensions that we are able to apprehend. It is not a mosaic with empty interstices, as the dermal organs and the rods and cones are. The field of objects is *full*, so to say. A steady change in any spatial qualification is then a continuous change; and that is all that movement is. It may be that, in some animals, perhaps the annelid worms, the only spatial qualifications are three vague and discrete 'therenesses,' *i.e.*, 'ahead,' "left," and "right"; but with us the objects either crowd each other or are separated by "room"; there is one continuous "field" wherein all changes, that is to say movements, are, in a sense, equivalent.

One of the informing things about the conditions of movement is the lower limit. We do not ordinarily see the minute hand move upon the watch-dial; though we may see it move upon the huge tower-clock when we climb up and observe it from inside. We sometimes say that we feel the cheek swell under the congestion of toothache, and we can really feel the balloon move in our hands under inflation. What we really see in the first case is that the watch-hand is at different places at different times; what we feel in the second is that the skin is more tense and the inflamed flesh more painful than it earlier was. There is then a minimal rate beyond which movement is not perceived. There is also a minimal distance upon the sensitive surface for the apprehension of movement. This distance is different in direct and indirect vision, being influenced by the rotation of the eye itself, and it is also different again for tactual perceptions on various parts of the body-surface. This minimal distance seems to bear some relation to the delicacy of discrimination for locality.

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[1] Cf. E. B. Titchener, *A Textbook of Psychology*, p. 357.

EXERCISES

1. Why is it so difficult to realize that an airplane, sailing above one, is really moving very rapidly?
2. Why is it that passengers in the basket of a balloon seldom have any feeling that they are moving? It is the earth that seems to move.

8. THE PLACE OF CONSCIOUS ACTIVITY IN THE PROCESS OF PERCEIVING[1]

BY GEORGE TRUMBULL LADD AND ROBERT SESSIONS WOODWORTH

A fact of profound and far-reaching psychological meaning comes to the surface repeatedly in considering the factors on which perception is based. The fact is this: We are often unaware of these factors, taken by themselves, and are even unable to become aware of them directly, though their reality can be demonstrated by their effects. We are unconscious, for example, of the existence of two fields of view, one due to each eye; and, in the case of double images, we are unable to tell by introspection which belongs to the right eye and which to the left. It may even happen that an object is visible only to one eye—as, for example, when the fingers of both hands are held before the eyes in a sort of lattice-work—and yet we cannot tell with which eye it is seen, or whether it is seen with both. Notwithstanding this inability to distinguish between the contributions of the two eyes, the facts of stereoscopic and especially of pseudoscopic vision show that binocular perception of depth depends on some sort of (physiological) distinction between the complex nervous impulses coming from the two eyes. To this corresponds the distinction (psychological) of the complexes of resulting sensations.

Again, perception of the distance of a familiar object and also perception of the size of an unknown object, when its distance is known, are both dependent on using the "visual size" of the object, or the angle subtended by it, as an indication of its real size or of its actual distance; and yet direct judgment of this visual size is much less certain and accurate than judgment of the real size or actual distance. These paradoxes would amount to genuine impossibilities if the whole process of reaching a judgment of size or depth went on within the field of consciousness, and if every part of it were accessible to attentive observation.

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[1] Adapted from *Elements of Physiological Psychology*, pp. 430–31. New York: Charles Scribner's Sons. Copyrighted, 1911.

Such experiences as these tend strongly—and, may we not say, conclusively?—to confirm our suspicion that innumerable complex "traces" of sensations due to native and acquired *motor* reactions are so fused with all the local signs of the retina, as to demand recognition in every satisfactory theory of the genesis and development of the entire class of visual perceptions. The infant does not even initiate, not to say achieve, the process of objective vision otherwise than through the use of a ceaselessly moving pair of eyes. And that our subsequent analysis, whether introspective or more purely experimental, cannot disentangle and reproduce in consciousness these fused, or synthesized, factors, no more proves that they did not formerly exist than does the similar inability of the accomplished violinist to reproduce all the sensations under the guidance of which he learned correct spacing and bowing for all the different "positions" of his instrument, and its most difficult and delicate work. Indeed, on the one hand, the player's violin is as much a seeming part of his own organism as is the seer's pair of eyes; and on the other hand, the complexity and depth below the threshold of consciousness, of the player's former sense-experience bears no resemblance to the complexity of the lost art of learning how to see with the average pair of eyes.

EXERCISE

1. Discuss some habits, other than habits of space perception, that involve unconscious factors.

CHAPTER XII

IDEAS AND ASSOCIATION

1. THE FORMS OF IDEATION[1]

BY EDWARD S. ROBINSON

Imagery is one form of ideation.—Whenever I have occasion to think of the school I first attended, an experience occurs that is very like actually seeing the red-brick building itself. Late one afternoon I set upon a walk with one of my friends. In my pocket I carried a letter that I intended to post in a box at the corner. After we had walked perhaps half a mile, I stopped suddenly and asked my companion whether I had posted the letter as we passed the box. He could not remember, nor could I for a moment or two. All at once an experience occurred which answered my question. I seemed to hear the post-box "thump" as it does when one lets go of the door. Now experiences like seeing a school house which was really miles away and like hearing the thump of the post-box which had been left behind some minutes before are called *images*. It is sometimes said that images are mental *pictures*, but that is not a very good way to put it, because images can be like sounds, tastes, odors—in short, like the perceptions through *any* of the other senses as well as like those through the eye.

An image is like a perception except that it is seldom as definite and that the object which the image represents is not actually affecting the sense-organ. The distinction between imagery and perception is usually an easy matter. Ordinarily, it is easy for me to know when I am looking at a house and when I am having an image of it. The image of the red-brick school building is not as vivid as the actual sight of the building would be and, furthermore, while I am aware of that image, I am also aware of other thoughts, objects, and so forth, which keep me reminded that I am miles away from the structure my image represents. Still, there are situations in which imagery is quite likely to be mistaken for perception. This is true in dreams. Although we are occasionally aware, while dreaming, that our dream-images are unreal, we are more frequently completely deceived by them until we awake. In conditions of great emotional excitement and in mental disorders there are very likely to be frequent confusions between imagery and perception. The two are also readily confused when external stimuli are weak. I have in my room a stubborn little clock which has the habit of stopping in the middle of the night, thereby causing me much inconvenience in the morning. One night, just before going to sleep, I listened to discover whether the clock was at work. The longer I listened the more uncertain I was as to whether I was hearing an actual "tick, tick, tick" or whether I was imagining it. When I finally got up and walked over to the clock, I discovered that it really had stopped and that the ticking was auditory imagery rather than perception.

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[1] Adapted by permission from *Practical Psychology*, pp. 229–35. New York: Macmillan Co. Copyrighted, 1926.

The uses of imagery.—Many people have noticed that as they have acquired a more thorough mastery of words and as they have become more and more concerned with relatively abstract affairs, their imagery has become extremely fragmentary. They have come to think in terms of words rather than in terms of images. The question has often arisen as to whether or not this loss of capacity for producing clear images is a disadvantage. It seems reasonable to suppose that vivid imagery may under certain circumstances be of considerable importance. Would not the poet be aided by a vivid visual image of the natural scene he is trying to describe from memory? Would not the inventor be aided by a clear visual image of his completed machine? Would not the composer be aided by being able in clear auditory imagery to go over the melody he is in the act of composing? It seems that the answer to all these questions should be an unqualified "yes." And yet the skilled psychologist will tell you that the matter is not so simple. Beautiful poetry *can* be written with scarcely any use of imagery. There have undoubtedly been capable poets who have thought directly in terms of the words they have written. It is possible to compose a melody without being aided by auditory imagery. The composer may sit down at the piano and make up the tune in terms of actual sounds without reference to any imaged ones. The machine-designer often has to have pencil and paper before he can begin to work. This is evidence that he does his thinking in terms of the lines he actually draws while thinking, rather than in terms of imagery. There is no doubt but that some poets, inventors, and composers, perhaps the majority of each of these groups, work out their poems, designs, and compositions through imagery, but it is our point that almost any result of thinking may be produced by any one of a number of forms of thought. The poet, while writing, may experience a visual image of the natural scene he is describing; the words he puts down upon paper may come to him as if spoken by another's voice; or he may be oblivious of almost everything except the actual movements of writing.

Form and reference of ideas must be distinguished.—A distinction must be drawn between *what ideas are about* and the nature of the ideas, that is, whether they are images, words, or of some other form. The reason why it has frequently been supposed that poets and inventors must have vivid visual images, that composers must have clear auditory images, and so on, is that there has been a constant confusion between *what the idea is about* and *the form of the idea.* Poets and inventors certainly do think *about* visual objects, about objects whose visual qualities are predominant over their other qualities. But this does not mean that these objects can be thought about only through visual imagery. If one has a sufficiently wide and accurate vocabulary there is hardly a visual quality that he cannot think about in verbal terms.

Language is another form of ideation.—Language is a form of thought which makes it possible for people to think together, to understand each other, and to carry on communication. But when a language is mastered it frequently replaces imagery, even in the private thinking of the individual. Some people cannot think easily unless they talk aloud to themselves. Some lecturers get their best ideas while they are actually lecturing. In these cases, thinking in terms of spoken words has become so habitual that thought goes on best in that form. Many of us who do not talk aloud to ourselves and who do not do our best thinking while speaking to other people, do nevertheless carry on our thinking in words. While absorbed in a train of thought, we are engaged in inaudible speaking. As a rule the person who thinks in this way is not aware of the form his thought is taking. He knows what he is thinking about, but the fact that he is really talking to himself wholly escapes his notice. Only careful self-observation is capable of revealing to him the manner in which he thinks.

Language has its written as well as its spoken form, and some persons, especially professional writers, get to a point where they depend upon paper and pencil, or typewriter. Their ideas, as was suggested when we were considering the poet's need of imagery, take the form of actual movements of writing.

It is the custom to think of the public speaker—that is, the extemporaneous speaker—as having ideas "in his head" which he translates into the spoken word, and of the writer as having ideas "in his head" which he translates into the written word. It is nearer the truth to think of the speaker's ideas as coming directly into his mouth and of the writer's ideas as coming directly into his fingers. Young writers are sometimes advised to "think right into the typewriter." This is only another way of saying that, if one wishes to write down ideas, it is better to have the ideas occur as writing movements than as images or spoken words which have to be translated into writing.

Words, themselves, may take the form of images.—We have described how ideas may occur as audible or inaudible speaking and as the actual movements of writing. Under these circumstances, thinking in verbal terms is something distinct from thinking in terms of imagery. It is perfectly possible, however, for thought to go on in terms of imagery and still be verbal thought. My idea of snow, for example, may take the form of a visual image of the printed word, "snow," or of an auditory image of the sound of the same word. It is even possible that, without actually making any such movements, I may have an image of the movements of tongue and throat when I pronounce the word.

Movement and bodily posture are sometimes ideation.—Movements other than those of speaking and talking may serve as ideas. Movements and postures which lie outside the realm of verbal language may be ideas in every sense in which images and words are ideas. The frown that crosses the meditator's face is not simply an outward expression of an idea. It frequently has of its own right, so to speak, a meaning and significance that make it an idea. The same thing is true of the many other changes in facial expressions, gestures, and muscular contractions and relaxations of trunk and limbs that take place during thinking. To the degree to which these acts stand for something beyond themselves they are ideas.

The form of ideation is sometimes undetectable.—We are at times quite clear as to the meaning of our ideation without being able to detect whether the ideas concerned are images or movements, verbal or non-verbal. At noon I may think that I ought to be stopping my work and going to lunch. If, after having undergone this process of thought or ideation, I ask myself just what images, movements, and words made up my thinking, I may be unable to give any account of them whatever. Professor Woodworth has given the following example of this point:

While reading I heard someone playing on the piano a piece which I felt at once to be familiar, but which I did not at once identify. My first attempt at identification was felt to be wrong, and immediately afterward I identified it properly and with confidence. In doing so I thought of the first part of the piece (it was Chopin's 'Funeral March,' and the part being played when it caught my attention was the trio). Resting satisfied with my identification, I was about to turn to other things, when it occurred to me to ask whether, in identifying the piece, I had had its name present in the form of verbal imagery, and I found that I certainly had not; in fact, it required a moment's further thought to recall the sound of the composer's name and the name of the piece. Nor, in locating the trio as a trio and thinking of the character of the march proper, did I have an auditory image of the march.[1]

It is, after all, not so strange that we are sometimes unable to describe in just what form our ideas occur. We have commented upon the fact that the expert performer of an act of manual skill can seldom describe in detail exactly how he accomplishes such good results. We are also familiar with the fact that many of the commonplace and oft-repeated acts of life go on so automatically that we are unaware of their precise nature. A person who has been reared in the South and who has a firmly established Southern accent may live for years in the North with little or no realization that his speech differs radically from that of his companions. Similarly, our thinking sometimes becomes so automatic that, although we know perfectly well what it is about, we do not know how it goes on.

EXERCISES

1. How is a person's thought affected by the size of his vocabulary?
2. Under what circumstances is a bodily movement an idea? Illustrate by giving a case of bodily movement that is an idea and another case of bodily movement that is not an idea.
3. Examine one by one each of the ten items in the list below. Think about each of the items, and then write a full account of the form of your thinking. Which ideas were in the form of images? What kind of imagery did you experience? Visual? Auditory? Any other kinds? Which of your ideas were in the form of words? Words spoken to yourself? Images of words? Which of your ideas were in the form of movements or of bodily postures? Did you think about anything without being able to detect how you thought of it? What?

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[1] Quoted from *Journal of Philosophy, Psychology and Scientific Method*, III (1906), 705, by Breese in *Psychology*, pp. 352–53.

A red rose
A train pulling out of a station
Lightning striking a tree
Onions frying in a pan
A band playing "America"
Climbing a flight of stairs
A table set for dinner
A strong wind
A bite of chocolate
A cold shower

4. Why is it of minor importance for practical life whether a man's imagery is mostly visual or mostly auditory?

2. THE IMAGE[1]

BY JAMES SULLY

Transition from percept to image: (a) The after-image.—Sensations have a temporary persistence under the form of the after-sensation. Since all sensations in mature consciousness instantly develop into percepts, we may express this fact of temporary retention as follows: All percepts, whether visual, auditory, or other, tend under certain circumstances to persist beyond the moment of the cessation of the sensory stimulus. Thus the perception of a bright object, as the setting sun, is often followed for some seconds by that which is known as an "after-image," but which may be just as appropriately described as an "after-percept," of the object. Similar after-percepts sometimes occur in the case of hearing, touching, and so forth. All such after-images are due to the continuance of the process of excitation in the nerve-centres engaged in the formation of the percept.

These after-images just referred to are known as "positive." They commonly occur immediately after the percept, and may be regarded as a prolongation of the same; but, in other cases, they recur for some little time, as, for example, after severe and protracted fixation of the eye on a microscopic preparation. They are distinguished from "negative" after-images, which arise from a temporary fatigue and disablement of the retina, either of all its supposed constituent elements (answering to different colours) or of some of these. The first effect is illustrated by the transformation of a positive after-image of a bright object, say the window, into a black image. The second effect is illustrated by the familiar colored images known as complementary spectra.

The (positive) after-images, or after-percepts, are phenomena of great psychological interest in relation to mental reproduction. They form the connecting link between percepts and images properly so-called (revived images). They approximate closely to complete percepts in respect of their psychical marks, namely, vividness or intensity (*i.e.*, degree of luminosity and strength or "saturation" of colour), distinctness of parts, and definiteness of localisation (either in the field of objects if the eyes are open, or in the dark field if they are shut). The chief difference consists in this, that they appear to shift their position in the field of view with every movement of the eyes. Thus the after-image of the sun's disc seems to move to the right of the dark field when we turn our eye in that direction. This is owing to the fact that they depend on a (relatively) permanent excitation of a certain portion of the retina, and not on the immediate action of an external stimulus.

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[1] Adapted from *The Human Mind*, I, 278–85. New York: D. Appleton & Co., 1892.

(b) **Primary memory-image.**—In addition to these after-images, which are only occasional and fugitive, a vivid and distinct impression, involving a special effort of attention, is apt to beget a mental image properly so called, which may persist for some time after the percept. Thus after intent visual inspection, as in microscopic investigation, the image of the object hovers about, so to speak, for some time, recurring again and again, as soon as other objects of attention are removed. This temporary image is important as forming the first stage of the true image. Hence it has been called the primary memory-image. Such temporary images may be observed to become little by little blurred and indistinct. There is thus a gradual subsidence or dying away of percepts.

Though shading off into the other when it occurs, the after-image or after-percept may commonly be distinguished from the primary memory-image by certain marks. The latter is, like all ideal or imaginative products of sensation, wanting in the full intensity or vividness of presentations (in respect of luminosity, force of colouring, and so forth). Moreover, even when it is definitely localised (as it is in the early stages) it is *fixed* in some region of external space corresponding to the place where the actual object presented itself, and so does not, like the after-percept, appear to shift its position with movement of the eyes.

This temporary persistence of percepts as images is a matter of great importance in the apprehension of all successions or series of impressions. Thus, in the perception of the time-relations of sounds it is evident that the grasp of the whole of a series, *a*, *b*, *c*, *d*, *e*, etc., as such, implies that the earlier members of the series, *e.g.*, *a* and *b*, persist when the later ones occur. Hence we may assume that the range of our grasp of successive impressions is limited by the persistence of such impressions. Recent experimental inquiry into what has been called the "span of prehension," or the number of sounds (*e.g.*, of letters or numerals) that can be repeated after a single hearing, shows that this power varies considerably, and, what is of great consequence, appears to vary with mental capacity generally. Experiment has also shown that the subsidence of the temporary image is a gradual one, and, after a time, reaches a stationary condition.

The revival of percepts.—This temporary "echo" of impressions or percepts, though it enables us to prolong, in a manner, the inspection of our percepts, has only a limited value in relation to the permanent acquisition of knowledge. When we talk of picturing, imagining, or mentally representing an object, we imply the appearance of the image *after an interval*. This resurgence of the image after the complete subsidence of the percept is popularly described as a revival or reproduction of the percept.

In speaking, however, of a "revival," "recalling," and so forth, of a percept, we must bear in mind that all such language is highly figurative. A percept is not a material object that persists, and can come and go. When I image a horse I have, as we shall see more fully presently, a different psychosis from what I have when I actually see the object. So far, indeed, is the image from being a reinstatement, that is, a renewed experience of the percept, that it carries with it in its representative function a more or less distinct reference to the sensation as something different. This reference in all cases of "recalling" proper involves a consciousness of the sensation as a *past* experience. The use of the expression representative image serves to bring out this distinctive peculiarity.

It is to be further noted that this revival under the form of an image holds good of all classes of percepts or "sense-impressions." Thus, in psychology, we speak of an image of a sound and of a taste, just as we speak of an image of a colour. Images derived from visual percepts are, no doubt, as we shall see, the larger and more important portion of our image-store, but we must keep steadily in view that other sense-experiences as well give rise to images. That is to say, the word image in psychology stands for every variety of percept (visual, auditory, etc.).

This revival of percepts after the lapse of time shows us in a striking form the effect of peripheral stimulation in modifying the nerve-centres by the foundation of "physiological dispositions." When Milton went on picturing objects with wonderful vividness and distinctness after the loss of sight, and Beethoven continued to imagine tones after he had lost his hearing, they gave signal proof of the power of the nerve-centres of storing up and afterwards using the effects of their past functional activity.

While we thus distinguish between the temporary after-effects of perception and the subsequent revival of percepts, we must not regard these as absolutely distinct. Not only is the primary memory-image the precursor and the guarantee of the later (secondary) image, but, in what is commonly spoken of as revival, recency of original impression is an important auxiliary factor. We may say generally that the revival of an impression is most perfect soon after the time of its actual occurrence, and becomes less and less perfect as the interval increases. We can commonly recall with ease, and a considerable degree of distinctness, a face or a *bon mot* that impressed us a few days before, though after the lapse of a month or six months the mind loses its hold on the impression.

Process of revival.—It has already been pointed out that, speaking psychologically, we only know retention through the fact of revival. If, as is supposed by Herbart, Hamilton, and others, a percept has any conceivable existence during the interval preceding revival out of consciousness or below the threshold of consciousness, we can have no direct knowledge of the fact; and it seems much more scientific, as already suggested, to confine ourselves to known psychical facts, and to speak of the percept being subsequently re-excited, or reproduced, under the new form of an image.

The immediate conditions of the appearance of the image are, as pointed out, the recurrence in restricted form of that mode of central excitation which conditioned the original impression. That is to say, I picture or have an idea of a rose when the group of nerve-centres engaged in the perception of this object are re-excited to similar functional activity.[1] The process of revival doubtless includes a stage, or rather a series of stages, of imperfect, that is, sub-conscious ideation. Thus, in imaging a rose, I can trace a process of gradual growth or formation of the image. This succession of a distinct on an indistinct stage does not, however, any more than the reverse process, the sinking or fading of the original, prove that the image existed previously.

Differentiae of images and percepts.—The fact that we have no difficulty in general in distinguishing between the percept and the image, *e.g.*, the sight of a horse and the mental representation of it, suggests that there must be certain differences between them. The most obvious point of difference is the greater intensity of the sensational or presentative element in the percept, which gives to the whole structure its peculiar vividness (or strength). Along with this superior intensity, and perhaps more important than this, is the greater distinctness of percepts, in general, as compared with images.

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[1] As pointed out above, the common assumption of physiologists and psychologists is that the cortical seat of a sensation and of its ideational correlative are one and the same. It follows from this that an image involves a reexcitation of that group of central structures (*e.g.*, visual and tactual) which is engaged in the process of perception. This hypothesis of one and the same central seat for sensation and idea is, as Ziehen has pointed out, not free from difficulties; at the same time his own attempt to mark off separate though connected cortical regions for the two phenomena seems to complicate the matter unnecessarily.

According to Hume, this exhausted the difference. But it is evident that this is not the whole of it; otherwise we should confuse weak and indistinct impressions, *e.g.*, those of faint sounds, or of indistinctly-seen objects, with images. Other differences assist in normal circumstances. One important distinguishing character of images is their unstable, changeable nature, as compared with the steadiness of percepts. Another point of difference is the presence in the percept and the absence in the image of the muscular and other sensations by which we know that we are using our eye or other sense-organ. Although when we visualize or visually imagine an object intently we undoubtedly have the eye engaged, the sensations are not the same. It is to be added that though in distinct mental picturing we roughly localize the image, referring it to the space *in front of us*, the localization is apt to be very vague and unsteady. This is probably owing to the circumstance that there is no definite fixation of the eye during an imaginative process. Other marks of difference present themselves when a closer examination is needed. Thus there is the obvious distinction that images are not affected by movement, as percepts are, which appear and disappear as the eye moves towards or away from a particular point.

With respect to the nervous processes involved, it is to be observed that while the central structures engaged in the case of a percept and an image, *e.g.*, seeing and imagining a colour, are supposed to be the same, there is the important point of difference that in the one case the excitation comes from the periphery, while in the other it is confined to the centre. It seems reasonable to assume that this would affect the psychical result in some way. And such an effect we appear to see in the several points of inferiority of the image just enumerated, more particularly the indistinctness, the fluctuating character, and the absence of those definite and palpable muscular and other sensations which constitute the basis of our reference of a percept to a particular peripheral organ, as the eye or the ear.

It may be added that such a distinction as we find drawn by normal persons when in health between the percept and the image obviously has a biological significance. If we were given to taking our images for percepts, so as to re-act upon them as such, we should plainly fail in biological adjustment. This failure shows itself in those distinctly abnormal states where the image reaches the stage of a hallucination and the subject directs his actions to imaginary as distinguished from real objects in his surroundings.

The question what are the precise psychical differentiae of percepts, or sensational phenomena and images is beset with considerable difficulty. On the one side we have the fact that, under normal conditions, we never take an image for a percept, or *vice versa;* on the other hand, there are the curious and perplexing phenomena of hallucination, that is to say, of images which, under special abnormal conditions, assume the appearance of percepts, and are (unless the tendency is corrected by reflexion) taken to be perceptions of real objects. It is commonly supposed that in the case of hallucinations the periphery is engaged. Thus in a visual hallucination the retina is supposed to be active just as it is when external light stimulates it. We see, moreover, in the fixation of the eye in hallucinatory states, and the definite localisation of the imaginary object, that the peripheral organ is much more deeply engaged than in the case of normal imagination. This favours the view put forward above that the (normal) image answers to restricted central activity, which has a somewhat different psychical accompaniment from the more extended activity (involving the periphery) which occurs in the case of the percept and presumably of the hallucination. It is to be added that even in perfectly normal states we do occasionally feel a moment's doubt as to the reality of sense-impressions, as, for example, in the case of feeble sounds; in which cases we determine the point by reflexion and reasoning. Lastly, it may be said that the abnormal development of images into percepts in the case of the insane, hypnotised subjects, and all of us during sleep, seems to show, as M. Taine has pointed out, that where there is no superior opposing force at work, due to stimulation of the peripheral sense-organs, the psycho-physical process of the image tends to develop into one indistinguishable from that of the percept.

EXERCISES

1. What reason can you give for the fact that the percept of a very faint sound is more easily mistaken for an auditory image than is the percept of a louder sound?
2. Would you expect visual images in a blind person who has been blind all his life? Why?

3. INDIVIDUAL DIFFERENCES IN IMAGERY[1]

BY FRANCIS GALTON

There is an absence of flexibility in the mental imagery of most persons. They find that the first image they have acquired of any scene is apt to hold its place tenaciously in spite of subsequent need of correction. They find a difficulty in shifting their mental view of an object, and examining it at pleasure in different positions. If they see an object equally often in many positions the memories combine and confuse one another, forming a "composite" blur, which they cannot dissect into its components. They are less able to visualize the features of intimate friends than those of persons of whom they have caught only a single glance. Many such persons have expressed to me their grief at finding themselves powerless to recall the looks of dear relations whom they had lost, while they had no difficulty in recollecting faces that were uninteresting to them.

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[1] Taken from *Inquiries into Human Faculty and Its Development*, pp. 108–13. London: J. M. Dent & Sons, 1883.

Others have a complete mastery over their mental images. They can call up the figure of a friend and make it sit on a chair or stand up at will; they can make it turn round and attitudinise in any way, as by mounting it on a bicycle or compelling it to perform gymnastic feats on a trapeze. They are able to build up elaborate geometric structures bit by bit in their mind's eye, and add, subtract, or alter at will and at leisure. This free action of a vivid visualising faculty is of much importance in connection with the higher processes of generalized thought, though it is commonly put to no such purpose, as may be easily explained by an example. Suppose a person suddenly to accost another with the following words:—"I want to tell you about a boat." What is the idea that the word "boat" would be likely to call up? I tried the experiment with this result. One person, a young lady, said that she immediately saw the image of a rather large boat pushing off from the shore, and that it was full of ladies and gentlemen, the ladies being dressed in white and blue. It is obvious that a tendency to give so specific an interpretation to a general word is absolutely opposed to philosophic thought. Another person, who was accustomed to philosophise, said that the word "boat" had aroused no definite image, because he had purposely held his mind in suspense. He had exerted himself not to lapse into any one of the special ideas that he felt the word boat was ready to call up, such as a skiff, wherry, barge, launch, punt, or dingy. Much more did he refuse to think of any one of these with any particular freight or from any particular point of view. A habit of suppressing mental imagery must therefore characterise men who deal much with abstract ideas; and as the power of dealing easily and firmly with these ideas is the surest criterion of a high order of intellect, we should expect that the visualising faculty would be starved by disuse among philosophers, and this is precisely what I found on inquiry to be the case.

But there is no reason why it should be so, if the faculty is free in its action, and not tied to reproduce hard and persistent forms; it may then produce generalised pictures out of its past experiences quite automatically. It has no difficulty in reducing images to the same scale, owing to our constant practice in watching objects as they approach or recede, and consequently grow or diminish in apparent size. It readily shifts images to any desired point of the field of view, owing to our habit of looking at bodies in motion to the right or left, upward or downward. It selects images that present the same aspect, either by a simple act of memory or by a feat of imagination that forces them into the desired position, and it has little or no difficulty in reversing them from right to left, as if seen in a looking-glass. In illustration of these generalised mental images, let us recur to the boat, and suppose the speaker to continue as follows:—"The boat was a four-oared racing-boat, it was passing quickly to the left just in front of me, and the men were bending forward to take a fresh stroke." Now at this point of the story the listener ought to have a picture well before his eye. It ought to have the distinctness of a real four-oar going to the left, at the moment when many of its details still remained unheeded, such as the dresses of the men and their individual features. It would be the generic image of a four-oar formed by the combination into a single picture of a great many sight memories of those boats.

In the highest minds a descriptive word is sufficient to evoke crowds of shadowy associations, each striving to manifest itself. When they differ so much from one another as to be unfitted for combination into a single idea, there will be a conflict, each being prevented by the rest from obtaining sole possession of the field of consciousness. There could, therefore, be no definite imagery so long as the aggregate of all the pictures that the word suggested of objects presenting similar aspects, reduced to the same size, and accurately superposed, resulted in a blur; but a picture would gradually evolve as qualifications were added to the word, and it would attain to the distinctness and vividness of a generic image long before the word had been so restricted as to be individualised. If the intellect be slow, though correct in its operations, the associations will be few, and the generalised image based on insufficient data. If the visualising power be faint, the generalised image will be indistinct.

I cannot discover any closer relation between high visualising power and the intellectual faculties than between verbal memory and those same faculties. That it must afford immense help in some professions stands to reason, but in ordinary social life the possession of a high visualising power, as of a high verbal memory, may pass quite unobserved. I have to the last failed in anticipating the character of the answers that my friends would give to my inquiries, judging from my previous knowledge of them; though I am bound to say that, having received their answers, I could usually persuade myself that they were justified by my recollections of their previous sayings and conduct generally.

The faculty is undoubtedly useful in a high degree to inventive mechanicians, and the great majority of those whom I have questioned have spoken of their powers as very considerable. They invent their machines as they walk, and see them in height, breadth, and depth as real objects, and they can also see them in action. In fact, a periodic action of any kind appears to be easily recalled. But the powers of other men are considerably less; thus an engineer officer who has himself great power of visual memory, and who has superintended the mathematical education of cadets, doubts if one in ten can visualise an object in three dimensions. I should have thought the faculty would be common among geometricians, but many of the highest seem able somehow to get on without much of it. There is a curious dictum of Napoleon I. quoted in Hume's *Précis of Modern Tactics*, p. 15, of which I can neither find the original authority nor do I fully understand the meaning. He is reported to have said that "there are some who, from some physical or moral peculiarity of character, form a picture (*tableau*) of everything. No matter what knowledge, intellect, courage, or good qualities they may have, these men are unfit to command." It is possible that "tableau" should be construed rather in the sense of a pictorial composition, which, like an epigrammatic sentence, may be very complete and effective, but not altogether true.

There can, however, be no doubt as to the utility of the visualising faculty when it is duly subordinated to the higher intellectual operations. A visual image is the most perfect form of mental representation wherever the shape, position, and relations of objects in space are concerned. It is of importance in every handicraft and profession where design is required. The best workmen are those who visualise the whole of what they propose to do, before they take a tool in their hands. The village smith and the carpenter who are employed on odd jobs employ it no less for their work than the mechanician, the engineer, and the architect. The lady's maid who arranges a new dress requires it for the same reason as the decorator employed on a palace, or the agent who lays out great estates. Strategists, artists of all denominations, physicists who contrive new experiments, and in short all who do not follow routine, have need of it. The pleasure its use can afford is immense. I have many correspondents who say that the delight of recalling beautiful scenery and great works of art is the highest that they know; they carry whole picture galleries in their minds.

EXERCISE

1. Examine your own mind. Compare the relative prevalence of mental imagery when you think about your different studies. If there are differences, can you explain them? Be sure to distinguish thinking *about* the visual and the auditory from visual and auditory imagery.

4. AN INTROSPECTION[1]

BY EDWARD BRADFORD TITCHENER

My mind, then, is of the imaginal sort,—I wish that we had a better adjective!—and my ideational type is of the sort described in the psychologies as mixed. I have always had, and I have always used, a wide range and a great variety of imagery; and my furniture of images is, perhaps, in better than average condition, because—fearing that, as one gets older, one tends also to become more and more verbal in type—I have made a point of renewing it by practice. I am able now, for instance, as I was able when I entered the class-room nearly twenty years ago, to lecture from any one of the three main cues. I can read off what I have to say from a memory manuscript; or I can follow the lead of my voice; or I can trust to the guidance of kinaesthesis, the anticipatory feel of the movements of articulation. I use these three methods under different circumstances. When it is a matter of preparing a lecture on a definite plan, of dividing and subdividing under various headings, I draw up in the mind's eye a table of contents written or printed, and refer to it as the hour proceeds. When there is any difficulty in exposition, a point to be argued *pro* and *con* or a conclusion to be brought out from the convergence of several lines of proof, I hear my own voice speaking just ahead of me; an experience which, in the description, sounds as if it should be confusing, but which, in reality is precisely the reverse. When, again, I come to a piece of straightforward narrative, I let my throat take care of itself; so that I am able to give full attention to blackboard drawing or to the manipulation of instruments on the table. As a rule, I look to all three kinds of prompting in the course of a single hour. At times, however, some one method is followed exclusively: thus, when I am tired, I find that vision and audition are likely to lapse, and I am left alone with kinaesthesis.

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[1] Taken by permission from *Experimental Psychology of the Thought-Processes*, pp. 7–11. New York: Macmillan Co. Copyrighted, 1909.

When I am working for myself, reading or writing or thinking, I experience a complex interlacing of imagery which it is difficult to describe, or at any rate to describe with the just emphasis. My natural tendency is to employ internal speech; and there are occasions when my voice rings out clearly to the mental ear and my throat feels stiff as if with much talking. But in general the internal speech is reduced to a faint flicker of articulatory movement. This may be due, in part, to the fact that I am a very rapid reader, and have tried to acquire the power of purely visual reading. But it is also due, I am sure, to the fact that I have vivid and persistent auditory imagery. If I may venture on a very sweeping statement, I should say that I never sit down to read a book, or to write a paragraph, or to think out a problem, without a musical accompaniment. Usually the accompaniment is orchestral, with a preponderance of the wood-wind,—I have a sort of personal affection for the oboe; sometimes it is in the tone-colour of piano or violin; never, I think, is it vocal. Usually, again, it is the reproduction of a known composition; on rare occasions it is wholly unfamiliar. I am not aware that I make any use of this musical imagery, though I should be sorry to lose it, and I can offer no explanation of its arousal. However, the important point in the present connection is, simply, that its freakish appearance has, without doubt, tended to repress the auditory factor in internal speech.

These musical and verbal images crop up of their own accord. I have never sought to control the former; I have, as I said just now, somewhat weakened the latter by my effort after purely visual reading. I turn now to the topic of visual imagery, which is always at my disposal and which I can mould and direct at will. I rely, in my thinking, upon visual imagery in the sense that I like to get a problem into some sort of visual schema, from which I can think my way out and to which I can return. As I read an article, or the chapter of a book, I instinctively arrange the facts or arguments in some visual pattern, and I am as likely to think in terms of this pattern as I am to think in words. I understand, and to that extent I enjoy, an author whom I can thus visualise. Contrariwise, an author whose thought is not susceptible to my visual arrangement appears to me to be obscure and involved; and an author who has an arrangement of his own, which crosses the pattern that I am forming in my mind, appears to me difficult and, to that extent, unenjoyable. Hence my standard of clarity and consistency is, in the last resort, visual. A writer may be discussing a highly complicated question; but if he is what I call clear, I can follow and understand him; his pattern is complex, but it may be traced. On the other hand, a writer may be discoursing in the easiest popular fashion; but if he is what I call obscure, if I cannot trace his pattern, I am baffled by him. I must then go to my friends, or to printed reviews of his work, and try to pick up a pattern at second hand.

EXERCISE

1. Write a detailed account of your own "furniture of images."

5 NUMBER FORMS[1]

BY FRANCIS GALTON

Persons who are imaginative almost invariably think of *numerals* in some form of visual imagery. If the idea of *six* occurs to them, the word "six," does not sound in their mental ear, but the figure 6 in a written or printed form rises before their mental eye. The clearness of the images of numerals, and the number of them that can be mentally viewed at the same time, differs greatly in different persons. The most common case is to see only two or three figures at once, and in a position too vague to admit of definition. There are a few persons in whom the visualising faculty is so low that they can mentally see neither numerals nor anything else; and again there are a few in whom it is so high as to give rise to hallucinations. Those who are able to visualise a numeral with a distinctness comparable to reality, and to behold it as if it were before their eyes, and not in some sort of dream land, will define the direction in which it seems to lie, and the distance at which it appears to be. If they were looking at a ship on the horizon at the moment that the figure 6 happened to present itself to their minds, they could say whether the image lay to the left or right of the ship, and whether it was above or below the line of the horizon; they could always point to a definite spot in space, and say with more or less precision that that was the direction in which the image of the figure they were thinking of, first appeared.

Now the strange psychological fact to which I desire to draw attention, is that among persons who visualise figures clearly there are many who notice that the image of the same figure invariably makes its first appearance in the same direction, and at the same distance. Such a person would always see the figure when it first appeared to him at (we may suppose) one point of the compass to the left of the line between his eye and the ship, at the level of the horizon, and at twenty feet distance. Again, we may suppose that he would see the figure 7 invariably half a point to the left of the ship, at an altitude equal to the sun's diameter above the horizon, and at thirty feet distance; similarly for all the other figures. Consequently, when he thinks of the series of numerals 1, 2, 3, 4, etc., they show themselves in a definite pattern that always occupies an identical position in his field of view with respect to the direction in which he is looking.

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[1] Adapted from *op. cit.*, pp. 114–16; 122–23.

Those who do not see figures with the same objectivity, use nevertheless the same expressions with reference to their mental field of view. They can draw what they see in a manner fairly satisfactory to themselves, but they do not locate it so strictly in reference to their axis of sight and to the horizontal plane that passes through it. It is with them as in dreams, the imagery is before and around, but the eyes during sleep are turned inwards and upwards.

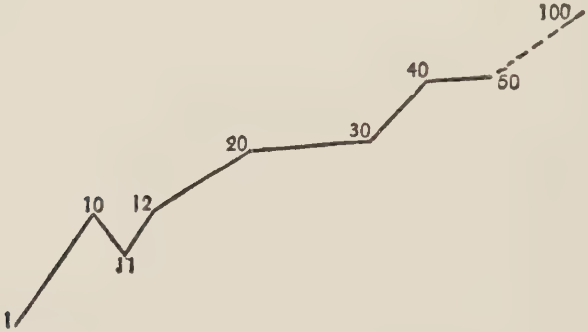

Fig. 76.—In this form the numbers are seen extending upward and to the right from about the level of the shoulders. (After Angell.)

The pattern or "Form" in which the numerals are seen is by no means the same in different persons, but assumes the most grotesque variety of shapes, which run in all sorts of angles, bends, curves, and zigzags (see Fig. 76). Drawings, however, fail in giving the idea of their apparent size to those who see them; they usually occupy a wider range than the mental eye can take in at a single glance, and compel it to wander. Sometimes they are nearly panoramic.

These Forms have for the most part certain characteristics in common. They are stated in all cases to have been in existence so far as the earlier numbers in the Form are concerned, as long back as the memory extends; they come into view quite independently of the will, and their shape and position, at all events in the mental field of view, is nearly invariable.

In some cases, the mental eye has to travel along the faintly-marked and blank paths of a Form, to the place where the numeral that is wanted is known to reside, and then the figure starts into sight. In other cases all the numerals, as far as 100 or more, are faintly seen at once, but the figure that is wanted grows more vivid than its neighbours; in one of the cases there is, as it were, a chain, and the particular link rises as if an unseen hand had lifted it. The Forms are sometimes variously coloured, occasionally very brilliantly. In all of these the definition and illumination vary much in different parts. Usually the Forms fade away into indistinctness after 100; sometimes they come to a dead stop. The higher numbers very rarely fill so large a space in the Forms as the lower ones, and the diminution of space occupied by them is so increasingly rapid that I thought it not impossible they might diminish according to some geometrical law, such as that which governs sensitivity. I took many careful measurements and averaged them, but the result did not justify the supposition.

It is beyond dispute that these forms originate at an early age; they are subsequently often developed in boyhood and youth so as to include the higher numbers, and, among mathematical students, the negative values.

EXERCISE

1. If you have a number form, give an account of it. Otherwise interview your friends until you find one who has, and then write down the account of it that you are able to get from him.

6. DOUBLE SENSATION OR SYNAESTHESIA[1]

BY GEORGE HENRY LEWES

The following case is of intense psychological interest. It reports what the narrator observes in himself, and in his brother; and the main facts have been controlled and verified by Prof. Brühl, so far as objective verification is possible in such a case.

Herr Nussbaumer and his brother from childhood upwards have always had sensations of colour simultaneously excited by sensations of sound. It is not simply that sonorous vibrations excite colours accompanying the sounds, but definite sounds excite corresponding definite colours. One of the brothers has a great facility in distinguishing the overtones which accompany the ground tone; yet very often when these overtones are delicate and breathlike, his perception of them is *somewhat disturbed by the accompanying colours.* Both brothers have been accustomed to designate particular tones by their attendant colours. The shrill womanly tones of some men's voices they call yellow; the rasping voices of some others they call greyish brown. When they were children it often occurred that some particularly agreeable tone made them exclaim, "What a lovely colour it has!"—which naturally excited the laughter of bystanders. In later years Nussbaumer learning that painters spoke of the tones of colour, and musicians of the colour of tones (*Klang-farben*), imagined that they also had the double sensation which he noticed in himself. But he learned on inquiry that this was not so; their terms were metaphorical.

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[1] Taken from *Problems of Life and Mind* (3d series), pp. 280–85. Boston: By permission of a special arrangement with Houghton, Osgood & Co., 1880.

To settle the question whether this double sensation was "mere phantasy," or "association of ideas," Professor Brühl tested Nussbaumer, and ascertained first that each particular note had constantly its corresponding colour; and secondly, that both brothers agreed in having the double sensation, but not precisely the same colours corresponding to the same notes—there was a general agreement, but with this some differences. The brothers had been separated for six years, during which period no communication on this subject passed between them. The one in Vienna, at the instigation of Professor Brühl, wrote down a score of questions, which the brother in Vicenza was requested to answer; these answers were handed in a sealed packet to the professor, in whose hands were the questions and answers of the Viennese brother. In the article from which I draw this account both questions and answers are given. They show that the phenomena are constant in both brothers, in spite of the minor variations. Thus the tone g'' as orange for one brother, and orange-yellow passing toward bluish for the other. The tone *e* has dark blue for one brother, and leathery yellow passing over into cornflower blue for the other. *D* has a mingling of dark blue and brownish violet for one, and chestnut brown with bright streaks for the other. When a chord is struck, one brother has a blending of colours passing from dark to bright, and from bright to dark; the other has a vividly changing mixture with sudden flashes of particular colours.

It is specially noticeable that red, green, pure white, and pure black are never excited in either of them by any tones or combinations. Blue, yellow, brown, and violet are the most frequent. The brother of Vicenza writes: "I don't know why you put the questions, nor what interest the answers can have for any one but ourselves. I only know that if I were a painter and a musician I could make colours represent every tone, and tones represent every colour, discords included."

Further, not only do colours accompany objective sound—those caused by sonorous vibrations—but they also accompany subjective sounds. When dreaming, if the brothers hear a trumpet or a drum, a shriek or other loud noise, there arise the same corresponding colours as those which arise in waking hours.

In answer to the suggestion that it is "owing to imagination," the writer says this can hardly be the explanation, for in the first place it was noticed by him when he was only four or five years old, and in the next place imagination is unable to picture red, green, black, or white, when sounds are heard. He has vainly tried to call up the subjective sensation of red; once he did succeed with green, but has never been able to repeat it. He cannot say what are the gradations of colour he finds in tones, because he must first hear the tones before he can name the colours, and very often not even then, because the colours are not such as he can name, he having never seen them objectively. He may remember to have seen the kind of colours but not these particular shades. Also a tone which has overtones sometimes appears in one shade of colour, sometimes in another, according to the strength of the overtones.

In ordinary life this accompaniment of colour is neither agreeable nor disagreeable, yet on some occasions, as in listening to a symphony, it will amount to a serious disturbance. He can, however, by an effort of concentration, rid himself of this incubus of colour, to attend only to the sounds.

Since becoming acquainted with this curious case I have sought far and wide for other examples of double sensation. But people are so little accustomed to note peculiarities in their sensations, unless these have some objective significance, that I could learn little. The following is taken from *Nature* (of May 17, 1877), where a correspondent says: "While lying awake a few mornings ago *with my eyelids closed* I was startled by a railway whistle. At the same instant I perceived a blaze of light on a dark ground, seemingly a few yards off. I made inquiry of my wife, who is of a much more nervous temperament, if she had ever observed such a coincidence, and was informed that in her case it is not a very infrequent occurrence." None of his scientific friends could tell him of cases of sounds exciting the sensations of colour. This is only an approximation to the Nussbaumer case; and it is an abnormal not a normal coincidence.

Many years ago a friend informed me that a glorious vision of flowers springing up in lovely tumult always accompanied a peculiarly powerful and pleasurable sensation. Mantegazza knows a man who cannot taste vinegar without at the same time having a sudden sensation of cold at the back of the neck. Every one knows the sensation in the forehead when hastily swallowing ice, and the "setting the teeth on edge" by scratching glass. A terrible sight always makes my legs feel cold, just as a horrible smell excites nausea.

Reflecting on Nussbaumer's case in the light of the few other analogous cases I could hear of, I began to consider whether the conjunction of two very different sensations was after all anything peculiar, whether, stated in more general terms, the normal process was not always that of one excitation being accompanied by nascent excitations, one feeling by other feelings; so that all individual peculiarities must be assigned to the kind and energy of these concomitants. Introspection will serve to assure us that every sensation has such an escort, which varies in energy and success; but since for the most part this retinue of subordinate excitations has no practical interest for us, it is disregarded, or only regarded when it has exceptional energy; just as we only notice the effect of sensation on the heart when the throb is energetic (and not always then), although it is demonstrable that every sensation does affect the heart. The Nussbaumers have other nascent states besides the more distinguishable states of colour, yet for some reason only these colour states appreciably emerge. I have many other feelings of various energy besides that of coldness in the legs when a horrible object is seen; but it is this coldness which obtrudes itself on my notice; probably because my attention having once been directed to it as peculiar, I have henceforward become accustomed to single it out. The Nussbaumers may in like manner have, so to speak, cultivated the habit of singling out the excitation of colour-feelings; though of course there must be some individual peculiarity in their organisms which renders the excitation of colour-feelings more definite and energetic than is common.

EXERCISE

1. Why would *coldness* accompanying the visual perception of ice attract less attention than *red* accompanying the auditory perception of a tone? Can you explain both cases by similar principles?

7. IMAGELESS THOUGHT[1]

BY BURTIS BURR BREESE

It has been very generally assumed that the content, or actual mind stuff of our thinking processes, is derived from sensory experiences—that the original material of thinking comes from the various senses. The contents of a thought-process would then be either a sensation, or a group of sensations (perception), or images or memories of these sensations and perceptions. Even the relational elements between the terms of thought are considered by some psychologists to have a sensory content. Titchener believes that the content of relational consciousness is given by motor tendencies, or attitudes, whose representations in consciousness are faint kinaesthetic sensations or images. Miss Washburn, writing on this same point, says that the relational elements of consciousness are the remnants of remote ancestral motor attitudes. The relational experience represented by the word "but," for instance, is now the vestige of the kinaesthetic sensations originally set up in primitive organisms by simultaneous stimuli calling for two incompatible reactions at the same time. The experience, she says, was that of a certain suspended, baffled motor attitude. In short, the theory of sensationalism holds that all consciousness, even the elements of reflective thinking, can be traced back to sensations. Even those who do not go the whole length of sensationalism, *i.e.*, those who are not willing to admit that relational elements and meaning are reducible to sensations, have all along assumed that every thinking process does contain sensory and imaginal content, and that thought cannot take place without some substantive content of a sensory character either directly experienced or imaged. The "no thought without images" theory has been recently and vigorously attacked by a group of American and German psychologists who believe that they have discovered "imageless thought." They contend that thinking may go on without any imaginal, or sensory, content whatever. According to them thinking may be carried on, and frequently is in its highest forms, in terms of a "pure thought element." This non-imaginal thought element can be detected by introspection, if we accept the statements of the imageless-thought psychologists. They claim that, when we think, there are elements of thought present in the field of consciousness which are neither sensory nor affective in character, but which nevertheless constitute a content of consciousness. They claim further that this content may exist independently of sensations or images. Thus Woodworth says: "According to my experience, the more effective the thinking process is at any moment, the more likely is imageless thought to be detected, provided only one introspects, which is not apt to be the case at such moments."

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[1] Adapted from *Psychology*, pp. 351–54. New York: Charles Scribner's Sons. Copyrighted, 1917.

It is claimed that the pure-thought element shows itself plainly in cases where we are given a definite mental task to do, such as that required in a laboratory experiment. At each command to make a definite reaction we know exactly what we are to do and yet there is no imagery of any kind whatsoever. The thought of the act, or the response, or whatever the task may be, is perfectly definite, and yet it is imageless. It is also claimed that meaning may be present in the mind alone without any image or sensory experience. The advocates of imageless thought contend that the meaning may exist in consciousness without the image. One may, they say, think of a thing purely in terms of its meaning without any visual, auditory, or other image of the thing.

Roughly speaking, there are at the present time three groups of psychologists distinguished by their attitudes toward imageless thought. First, there are the sensationalists who believe that all thought processes are carried on in terms of sensations, or images, or both. They believe that meaning and relational consciousness are represented by sensory content of some kind. Second, there are those who accept the "directive tendencies" and "conscious attitudes" as phases or even contents of consciousness, but they believe that they are always attached to sensory, or imaginal factors and do not exist alone in consciousness. Third, there is a smaller group of psychologists who believe in the existence of a "pure thought content," independent of any sensory or imaginal content.

EXERCISE

1. Why, in your opinion, is it possible for competent men to hold such conflicting opinions in regard to whether or not there can be sensationless and imageless thought?

8. ASSOCIATION OF IDEAS[1]

BY JAMES R. ANGELL

It remains to examine some of the principles determining the sequence of the successive links in a chain of thoughts or images. This is a problem which has interested every generation of psychologists from Aristotle down to the present time.

The association of ideas.—That ideas which have for any reason been connected with one another in the past tend to hang together, so that if one presents itself to the mind the others tend to come with it, has attracted again and again the attention of even superficial observers. In like fashion the tendencies of ideas to suggest others which resemble them has repeatedly been noticed.

Association and the law of habit.—All the principles of association may be considered as in one way or another expressions of the general law of habit. *Frequency* of connection is the most obvious instance of the principle. Ideas which have been frequently united tend to recall one another at the expense of less frequently connected thoughts. The date 1492 is in this way associated with Columbus. *Intensity* in an experience may serve to bind permanently together psychological elements that otherwise would never suggest one another. The thoughts of the several moments of a very terrifying experience, *e.g.*, escape from a sinking ship, may thus become permanently fused. Again, the *recency* of a conjunction may bring it about that the train of ideas reflects this connection, rather than others which have been more frequent, and even some which may have been more intense.

Evidently these three factors, if they were the only influences at work, might make it substantially impossible to predict in a given case what associations should actually dominate, because it might well occur that a particular idea *a* should have been frequently connected with *b*, recently connected with *c*, and at some remote time vividly connected with *d*. Synaptic conditions would therefore permit that the idea *a* should lead to *b*, *c*, or *d*. Which one actually succeeds *a* will depend upon the momentary condition of the brain, which we have no means of determining. Meantime, it is clear enough that the sequence of ideas is determined by perfectly definite causes, even if we are not in a position to state in a given case just what they are.

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[1] Adapted from *An Introduction to Psychology*, pp. 160–64. New York: Henry Holt & Co., 1918.

Undoubtedly among the most important determining factors are our interests, temporary or permanent, and our emotional mood. If our minds are preoccupied with some exciting or entertaining train of thought, it is practically impossible for ideas connected with wholly different topics to arise. Similarly if we are in the clutch of any strong emotion, only such ideas as are relevant to its course can get a hearing, or indeed, can reach the field of consciousness at all.

No account of association would be correct which implied that the succession of ideas one upon another could be explained in terms of single ideas. For example, the fact that idea *b* follows idea *a* is probably never completely to be accounted for by the presence of *a* alone. Certainly in all ordinary instances the appearance of *b* is due to the entire context amid which *a* appears. Thus the idea wood brings up an entirely different group of associates when it occurs in connection with the search for fuel and in connection with an examination of furniture. The memory of words affords innumerable instances of the same kind of thing.

The association of similars.—Few forms of association have attracted more attention, and perhaps none is more significant for human thought processes, than that of *resemblance*, or *similarity*. The older writers on psychology used to group the various forms of association under the headings contiguity in space and time, similarity, contrast, cause, and effect. The reader will readily recognize that we have already in substance dealt with the case of contiguity and to some extent with that of cause and effect. In our original comments upon association were cited instances in which ideas which had previously occurred together, or in immediate succession, tended to recall one another. Associations involving contrast, *e.g.*, black-white, large-small, etc., are closely related to the cases of contiguity and we shall not pause to discuss them, but a few further words must be devoted to associations involving similarity.

It is in this type of associative sequence that we seem to break most completely with past experience and seem to achieve freshness and originality in the order of our thought. It has often been said, and probably with much truth, that it is our wide and subtle use of this kind of associative nexus which marks us off most unequivocally from the animals. Ideas which are similar may recall one another, even though they have never before been in any way immediately conjoined in a thought process.

EXERCISE

1. Below is a list of words. Cover this list with a card in such a way that by moving the card down the page you will uncover the first word in the list, then the second, and so on. As soon as you see the first word, write down the first word that comes to you. For example, if one looked at the word "house," he might think immediately of "barn." Explain these associations in terms of *frequency*, *intensity*, *recency*, and the other factors discussed above.

Table
Dark
Music
Sickness
Man
Deep
Soft
Eating
Mountain
House

CHAPTER XIII

MEMORY

1. MEMORY IN ITS EFFECTS[1]

BY HERMANN EBBINGHAUS

The language of life as well as of science in attributing a memory to the mind attempts to point out the facts and their interpretation somewhat as follows:

Mental states of every kind,—sensations, feelings, ideas,—which were at one time present in consciousness and then have disappeared from it, have not with their disappearance absolutely ceased to exist. Although the inwardly-turned look may no longer be able to find them, nevertheless they have not been utterly destroyed and annulled, but in a certain manner they continue to exist, stored up, so to speak, in the memory. We cannot, of course, directly observe their present existence, but it is revealed by the effects which come to our knowledge with a certainty like that with which we infer the existence of the stars below the horizon. These effects are of different kinds.

In a first group of cases we can call back into consciousness by an exertion of the will directed to this purpose the seemingly lost states (or, indeed, in case these consisted in immediate sense-perceptions, we can recall their true memory images): that is, we can reproduce them *voluntarily*. During attempts of this sort,—that is, attempts to recollect—all sorts of images toward which our aim was not directed, accompany the desired images to the light of consciousness. Often, indeed, the latter entirely miss the goal, but as a general thing among the representations is found the one which we sought, and it is immediately recognised as something formerly experienced. It would be absurd to suppose that our will has created it anew and, as it were, out of nothing; it must have been present somehow or somewhere. The will, so to speak, has only discovered it and brought it to us again.

In a second group of cases this survival is even more striking. Often, even after years, mental states once present in consciousness return to it with apparent spontaneity and without any act of the will; that is, they are reproduced *involuntarily*. Here, also, in the majority of cases we at once recognise the returned mental state as one that has already been experienced; that is, we remember it. Under certain conditions, however, this accompanying consciousness is lacking, and we know only indirectly that the "now" must be identical with the "then"; yet we receive in this way a no less valid proof for its existence during the intervening time. As more exact observation teaches us, the occurrence of these involuntary reproductions is not an entirely random and accidental one. On the contrary they are brought about through the instrumentality of other, immediately present mental images. Moreover they occur in certain regular ways which in general terms are described under the so-called "laws of association."

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[1] Taken from *Memory*, pp. 1–2. (Translated by Henry A. Ruger and Clara E. Bussenius.) New York City: Teachers College, Columbia University, 1913.

Finally there is a third and large group to be reckoned with here. The vanished mental states give indubitable proof of their continuing existence even if they themselves do not return to consciousness at all, or at least not exactly at the given time. Employment of a certain range of thought facilitates under certain conditions the employment of a similar range of thought, even if the former does not come before the mind directly either in its methods or in its results. The boundless domain of the effect of accumulated experiences belongs here. This effect results from the frequent conscious occurrence of any condition or process, and consists in facilitating the occurrence and progress of similar processes. This effect is not fettered by the condition that the factors constituting the experience shall return *in toto* to consciousness. This may incidentally be the case with a part of them; it must not happen to a too great extent and with too great clearness, otherwise the course of the present process will immediately be disturbed. Most of these experiences remain concealed from consciousness and yet produce an effect which is significant and which authenticates their previous existence.

EXERCISES

1. To what extent is perception an effect of memory?
2. How are habit and memory related?

2. THE NATURE OF REMEMBERED IDEAS[1]

BY GEORGE MALCOLM STRATTON

The rapid and then more gradual blurring of our impressions as time goes by must not be confused with the actual distortion which events often undergo in memory. Memory is often thought of as illustrating the constancy of our ideas. We speak of things as indelibly stamped or graven on the mind, or liken memory to a gallery where the past is preserved in lasting pictures. If ideas were actually stored up in memory as permanent and stable realities, still existing during the interval of forgetfulness, we might expect them usually to appear unchanged as we recalled them at different times. But there is often the greatest contrast between my present recollection of an event and my recollection of it some moments hence. The memory not only grows less clear, but it actually tells a different story as time proceeds. Now there is in psychology a frequent confusion of these two independent facts of memory,—the fact of forgetfulness in the sense of blurring, and of forgetfulness in the sense of distortion. We are at first naturally tempted to represent forgetfulness merely after the manner of a light that fades, or of a substance that evaporates or melts away. If the latter figure of speech represented the facts, there would most naturally be a change in the quantity of objects as we forgot them. A half-forgotten house might be but half the size of the same house fully remembered. Or a fire in memory would, perhaps, give out but a fraction of the warmth that we enjoyed as we sat beside it; a recalled pound might weigh but an ounce, and so on.

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[1] Adapted by permission from *Experimental Psychology and Its Bearing upon Culture*, pp. 169–70. New York: Macmillan Co. Copyrighted, 1908.

EXERCISE

1. What is retained when we remember (*a*) a poem, (*b*) the appearance of a friend, (*c*) how to swim?

3. MEMORY AND REPRODUCTION[1]

BY OSWALD KÜLPE

The fact implied in the terms *memory* and *reproduction*, and in part also in *recollection*, is simply this: that an impression which has been produced in the past by a particular stimulus does not disappear outright with the cessation of that stimulus, but is somehow conserved, and, under certain conditions, has the power of again becoming a noticeable part of conscious contents, without any renewal of the original peripheral stimulation. We often explicitly recognise it on its reappearance as the same impression, and are frequently able to describe the circumstances of its original production. From these facts it is conjectured that even in the not very uncommon cases where there is no *recognition*, general or special, the centrally excited sensations are still merely "reproductions," "memorial" or "fancy images" of previous peripherally excited sensations. If we abstract from the metaphysical ideas which have clustered round the phenomena (one theory consigns the images to the care of an unconscious mind, another makes the brain deposit its sensory excitations in particular ganglion cells), we have in this view a generalisation of experiences of whose reality there can be no doubt. The word "memory" lays particular stress upon the latency of the "conserved" impressions; "reproduction" and "recollection" upon their recurrence in consciousness.

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[1] Taken from *Outlines of Psychology*, p. 170. (Translated from the German [1893] by Edward Bradford Titchener.) London: Swan Sonnenschein & Co., 1895.

EXERCISE

1. Why does Külpe speak of images as "centrally excited" sensations?

4. EXPERIMENTAL STUDIES OF MEMORY[1]

BY JOHN A. MC GEOCH

I. INTRODUCTION

The Meaning of the Term 'Memory' in Experimental Psychology. It is customary to say that memory has four parts or phases: learning or memorization, retention, recall, and recognition. From an experimental standpoint, however, the two fundamental processes are memorizing and retaining. We measure the first in terms of how much is learned in a given length of time and under specified conditions. We measure the second in terms of how much of a previously learned material can at some later time be reinstated or utilized. Recall and recognition may be viewed as two ways of measuring retention and we shall treat them in this way.

Learning versus Retention. In experimental psychology the word *memory* is used to cover both memorizing and retaining, although the more common, untechnical usage makes it mean the act of reviving a past experience as apart from its acquisition. We shall mean by memorizing the act of learning such things as lists of words, poetry, the content of passages read, and ideas generally; and by retaining, the fact that such learned materials can at some later time be reinstated or at least have some measurable influence upon relearning.

Actually, of course, learning and retention are not clearly separable processes. When one has, for example, read over a list of words once, he retains some effect of the reading. The next reading will be influenced by the first, the third reading by the first and second, and so on until the list is completely learned. Thus, after the first reading of or exposure to any memory material, succeeding readings or exposures build upon the effects of those preceding. The beneficial effects of repetition depend upon the persistence or retention of the effects of preceding repetitions. If such effects did not persist, any number of repetitions beyond one would have no more value than would one alone. Learning and retention are, therefore, so interconnected that they can be separated only arbitrarily. Psychologists have found it convenient to classify those experiments which are primarily concerned with the acquisition of any memory material as experiments in learning or memorizing, and those which aim to measure the retention of such material at any time *after the learning proper has ended* as experiments in retention. It must always be remembered, however, that the learning period involves retention as one of the conditions of its effectiveness. In this discussion, the data of the experimental work on learning will be treated separately from the data of experiments on retention, and the persistence of the effects of each successive learning trial will be taken for granted. In a separate section, the results of experimental work on the retention of acquired material at some time after the cessation of the learning-period will be presented.

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[1] Bibliographical references to the major number of experimental studies discussed in this section may be found in E. L. Thorndike, *The Psychology of Learning* (*Educational Psychology*, Vol. II) (New York: Teachers College, 1913); W. H. Pyle, *The Psychology of Learning* (Baltimore: Warwick and York, 1928); E. S. Robinson, "Memory," *Psychol. Bull.*, XXI (1924), 569–94; and J. A. McGeoch, "Memory," *Psychol. Bull.*, XXV (1928), 513–49.

It should be obvious from what has been said that one cannot think of memory as a faculty, an entity or thing. Memory is not *something* which one has in various amounts. It is a name for the functions of memorizing and of reinstating or reviving at some future time that which has been memorized. Memory, as such, apart from the functions of memorizing and retaining, has no known existence.

Memory versus Habit. Learning and retention fundamentally include every kind of mental acquisition and retention of that which has been acquired on the part of a living individual. Psychologists usually make a working distinction, however, between habit and memory. Both involve learning and retention of what has been learned. The term habit is used to refer to an act or series of acts which have been acquired and perfected to a point where they are always performed when the proper stimulus is applied. They are very nearly automatic and they refer, also, to acts of a non-verbal sort, usually to those which require to a fairly large degree the use of the skeletal muscles of the body. Typewriting, playing tennis, and driving a car are examples of such habits. Memory, on the other hand, is the term used to designate the acquisition and retention of words, ideas, and in short any experience of a kind not involving, as one of its major conditions, large movements of the skeletal muscles.

The distinction between habit and memory is far from being a clean-cut one. The acquisition of practically every habit involves some ideation and verbalization; and the learning of ideas and words involves more or less muscular movement. Further, they cannot be distinguished clearly in terms of automaticity. It is often said that habits function automatically and usually in the same manner upon the presentation of the stimulus, while memories are not thus automatic and invariable. This is, over a wide range of cases, a true description of observed differences between them. It is not, however, an inherent or necessary distinction. An idea or a word may be called forth by a stimulus with as great an automaticity and invariability as a gross and overt act. Practically, not many ideas and words are as invariable as this. But as long as some are, the distinction between habit and memory in terms of automaticity and invariability breaks down for any except the practical purpose of classification.

For the purposes of experimental psychology we use this rough classification, and we shall consider under the name of memory only those learning activities in which the motor side tends to be at a minimum, such as learning vocabulary lists, poems, ideational systems of knowledge, and other similar materials. Virtually all of these involve, at the beginning of the learning period, some ideation and a high degree of invariability. With sufficient practice or repetition they may become almost invariable and may involve no ideation. Actually, however, the process of memorization is seldom carried to this point.

Experimental Materials. Theoretically, any verbal or ideational material whatever might be used in studying memory; practically, there are certain demands made by the usual type of experimentation which are best met by a few materials only. The most frequently used material has been nonsense syllables, which were first employed by Ebbinghaus. A nonsense syllable is any combination of a vowel between two consonants which does not "make sense" or have meaning in any language known to the subject who learns it. Such syllables as BEJ, QOW, and XAD are examples.

Nonsense syllables have certain outstanding advantages as memory materials. In most experiments we require a large number of different lists or sections of the material to be memorized; these must be as nearly equal in difficulty as possible; and of course all of the subjects must be equally unfamiliar with them. Lists of sense words or stanzas of poetry do not meet these requirements very well. It is hard to get many lists or stanzas which are of equal difficulty and equally unfamiliar to all subjects, because most of them have had a much wider acquaintance with words and poetry than with nonsense syllables. Such materials as French, physics, history, or pictures offer still greater difficulties of the same kind. On the other hand, 2019 nonsense syllables can be constructed from the English alphabet and these can be arranged in lists of very nearly equal difficulty.

Glaze has recently refined the nonsense syllable as an experimental instrument by classifying the 2019 possible syllables according to their association value. He exposed each syllable singly to each of 15 college students and asked the student to indicate whether the syllable had any meaning for him. At the end of the experiment the syllables were classified with respect to the percentage of the subjects to whom it was meaningful. If every subject found a syllable to have meaning for him, its association value would be 100 per cent. If 14 out of the 15 subjects found a syllable to be meaningful, its value would be 93.33 per cent, and so on. If a syllable meant nothing to any subject, it would have an association value of 0 per cent. The syllables BAL, SOC, and WIL, for example, are in the 100 per cent list, while VUP, GAH, and ZIW are in the 0 per cent list. Having a large number of syllables of known association value, an experimenter can construct lists of much more nearly equal difficulty than was possible before the publication of Glaze's work.

In experiments where it is not necessary to have large numbers of equal sections of the memory material, poetry, prose, pictures and the like have been used. To a very large extent it has been found that the generalizations worked out by the use of nonsense syllables hold for other kinds of memory material.

Experimental Methods. There have been worked out, during forty years of research on the problems of memory, a large number of careful experimental methods. These have to do with the presentation of the material and with the control and measurement of the progress of learning. We may present the learning material to the subject all at once or serially, and there are available several types of apparatus for controlling the time of presentation in either case. The subject may learn either very incompletely or to complete mastery and beyond; and we can measure his progress either by his attempts at recitation during the course of learning or by how much he retains immediately after the close of the learning period. For the measurement of retention, either immediately after learning or at any later time, there are three chief classes of methods. The subject may be asked to recall or reproduce what was previously learned; he may be set the task of recognizing the learned items among new ones of similar kind; or he may relearn the material, in which case the retention is scored in terms of the percentage which the trials required for relearning are of the original learning trials. This is called a saving score. It is interesting that one may be totally unable to reproduce or to recognize any of a previously learned material and yet relearn it with a substantial saving.

The Experimental Problems of Memory. The experimental attack upon the field of memory dates from 1885, when Hermann Ebbinghaus published a monograph called *Memory*, in which he set forth the methods and results of a long series of careful experiments upon himself. This monograph was the first systematic attempt to deal quantitatively with the so-called "higher mental processes," of which memory is one. The absence of experimental work upon memory prior to the days of Ebbinghaus is but a special instance of the prevailing belief that mind could not be laid out by rule and measure, particularly its more complex and 'higher' aspects. Ebbinghaus' experimental demonstration that memory could in many ways be dealt with quantitatively—laid out by rule and measure—marked an epoch-making contradiction of the then current belief and inaugurated an experimental attack upon memory functions which has proved to be one of the most important movements in experimental psychology. To his work we owe many of the problems and methods discussed in this section, as well as many important results. So thorough was his work that, even though it was done upon only one subject, many of his results are of general significance. Repetition with large numbers of subjects of much of his work has yielded results closely similar to his own.

A survey of the chief groups of experimental problems will be a necessary introduction to the results themselves. The problems may be divided into four classes with their sub-groups. The main classes will be mentioned here and the sub-groups will appear in their proper places in the discussion later. (1) *The curve of memorizing.* We seek here to discover the way in which learning proceeds during the length of the practice period, how much is learned in different portions of the period, and the factors which will affect the form of the resulting curve.

(2) *The factors affecting memorizing.* The general problem is to find the factors which hasten and retard the rate of learning and to measure the amount of their influence. (3) *The curve of retention.* We wish to know what happens to the acquired material from the moment that the learning period ends until some indefinite future time. That is, when we plot amount retained against the intervals of time from the end of learning onward, what form will the curve assume and what factors affect this form? (4) *The factors affecting retention.* The problem is to discover the conditions which affect forgetting or its converse, retention, and to measure their influence. These will be divided into primary and secondary factors.

II. THE CURVE OF MEMORIZING

We may express a subject's progress in memorizing by drawing a curve that will show the amount learned at each successive trial or repetition. This is called a curve of memorizing. Theoretically such a curve may take any one of three general forms as shown in Fig. 77. Curve A is negatively accelerated. It shows that the learner acquired more of the material in the first part of the learning-period and relatively less in the last part. The curve thus slows down or decelerates as it goes on. Curve B is linear, indicating that equal amounts were learned at each successive trial. Curve C is positively accelerated. During the first trials learning was slow, speeding up as practice proceeded. These are smooth, schematic curves. The experimentally obtained curves, even when records from large numbers of subjects are pooled, are more irregular than these, although the experimental curves approach these as a limit.

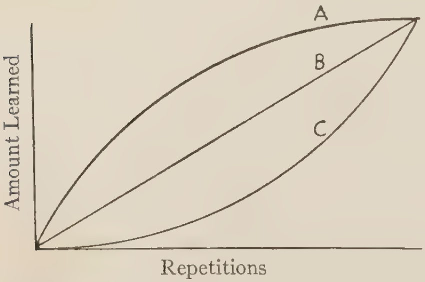

FIG. 77.—Three types of memorization curves. (After Carr, *Psychology*.)

In Fig. 78 the memorization curve of one subject for an 8-syllable list is drawn. The subject, a college student, learned to complete mastery. It can be seen at once that in spite of the irregularities the general form of this curve is that of Curve A in Fig. 77. Half of the list had been learned at the end of the third trial, but seven more trials were needed for the relearning of the remaining half, thus giving a pronounced negative acceleration. Memorization curves of this form are the most common ones. The slope of the curve will vary with different learners, but the uniformity in general shape is more prominent than any of the differences in slope.

The shape of the memorization curve varies with the learning material. Nonsense syllable lists, for example, typically give a curve with great negative acceleration. Some paired associates, such as numbers paired with syllables or names with faces, have been found to give linear or slightly positively accelerated curves. The experiments which show any large deviation from the negatively accelerated curve-form are, however, few. There is a clear general tendency for learners, under most experimental conditions, to learn relatively more in the early than in the late portions of the learning period. It is significant, moreover, that as a learner becomes more practiced at learning the number of trials necessary to acquire equal sections of material becomes less, but the form of the memorization curve remains essentially unchanged.

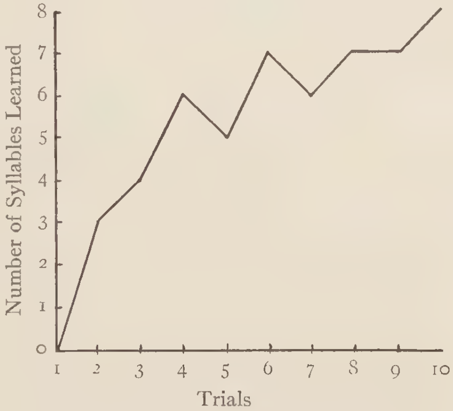

FIG. 78.—Memorization curve of one subject

This prevalent negative acceleration is, at least in part, a result of the fact that all items in a list are not of equal difficulty. One experimenter had subjects learn lists of paired words of unequal difficulty and found that a majority of the easy pairs were learned in the early trials, while the hard pairs were distributed rather equally over all of the trials. Fig. 79 shows this difference clearly. It is constructed from twenty-one records in all of which five trials were required for the learning of lists of sixteen pairs each. The curve for the easy items is negatively accelerated; that for the hard items shows a slight positive acceleration.

If twenty subjects learn the same list to complete mastery, only a few of them, if any, will take exactly the same number of trials. If one takes but three trials and another twenty-five with the other subjects scattered in between, it is obviously inaccurate to add together the numbers of syllables learned by all of the subjects at each trial and then to draw the curve from the combined records. By this method the complete learning of the subject who required three trials would be added to the first three trials of the one who took twenty-five trials and so on. This would not give a true picture of the results. We can fairly combine in this way only the records of those who took the same number of trials, as in the experiment just described.

It is often desirable to combine the records of all the subjects used in an experiment into a single memorization curve. Dr. Vincent, in a study of the maze-learning of white rats, once worked out a method for combining different curves which has since been used frequently, with modifications, in studying the memorizing of human subjects. In drawing the Vincent curves for nonsense-syllable learning, the trials or the time required by each subject are divided into equal parts, such as sixths or tenths. If a subject took twelve trials, each sixth would include two trials; if another took twenty-five, each sixth would include six and a fraction, and so on for each subject. Then the percentage of the total list which was learned in each sixth of the time or trials is computed. Since these percentages are obtained for equal units (sixths) of the learning time, regardless of the absolute amount, we may add together the records for all subjects at each sixth and draw a composite curve.

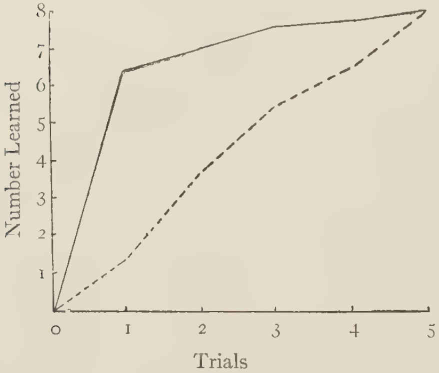

FIG. 79.—Memorization curves for easy and hard items. (From data of G. M. Peterson, *J. Exper. Psychol.*, XI [1928], 42.) Solid line represents easy items, broken line hard items.

This method of combining records has the disadvantage of getting away from the raw experimental data, but in several experiments its use has led to very significant results. Kjerstad has used it in studying the influence of length of list upon the form of the memorization curve. He found that with several different learning materials the form of the curve was independent of the length of the list. This generalization has since been verified by Robinson and his associates, and some of their results are shown in Table VIII.

It can be seen at once that in each sixth of the total learning time practically equal percents of the total lists were learned, regardless of the length of the list. Were these figures expressed in the form of a curve, the four curves would be virtually coincident The *Kjerstadt-Robinson* law that the form of the Vincent curve of memorization is a constant, regardless of the length of the list, holds for a wide range of serially learned materials. It has, however, a lower limit. It does not hold for short lists of four three-place numbers nor for six nonsense syllables. It may also have an upper limit, but this is as yet undetermined.

This problem of the temporal course of learning, or of how learning proceeds in different parts of the learning-period, is important both from the standpoint of the nature of memorizing and from that of the experimental attack upon the factors affecting memorizing. The field of the curve of memorization is far from being completely explored. It is probable that other factors yet unexamined experimentally affect its course. It may be, for example, as Culler has been showing in the case of the curves for the acquisition of habits, that the customary negatively accelerated curve is but the middle section of a more general S-shaped curve which we should find if our laboratory subjects started at a real zero point with reference to the material learned. This hypothesis and the influence of numerous experimentally controllable factors upon the form of the curve offer a rich field of research.

TABLE VIII

PERCENTAGES OF LISTS OF DIFFERENT LENGTHS LEARNED IN SIXTHS OF THE TOTAL TIME SPENT IN LEARNING

(From Robinson, Heron, and Darrow: *J. Exper. Psychol.*, 1922, 5, 428–448; and *Amer. J. Psychol.*, 1924, 35, 235–243.)

Percentages of Total Learning Time	Number of Syllables in List			
	9	12	15	18
16.7	33.9	34.6	30.9	33.1
33.3	51.2	52.3	52.2	53.2
50.0	62.0	66.3	62.0	66.3
66.7	73.6	74.9	74.2	76.3
83.3	80.8	80.5	80.3	82.8
100.0	100.0	100.0	100.0	100.0

III. THE FACTORS AFFECTING MEMORIZING

The search for the factors affecting memorizing and the study of their influence make up the second great class of experimental problems in the field of memory. The problem here is not that of the course of learning over whatever time is required to learn, but to discover what factors affect this time itself and in what way. The student will remember that the form of the curve seems to be independent of the absolute amount of time spent or number of trials taken, and will readily see that the shape of the curve and the factors affecting the time taken to learn are, thus, two independent problems.

THE CHARACTER AND LENGTH OF THE MATERIAL

Meaningful versus Non-meaningful Material. Memory material may be almost completely devoid of meaning, as are the syllables with 00.00 per cent association value in Glaze's lists, or it may be highly meaningful, as is familiar prose or the well-understood principles of any field of knowledge, or it may be distributed in between these two extremes of meaningfulness. In experimental work of this kind it is customary to accept a common sense working definition of meaning and to make no attempt at a more systematic definition. The term is here used in this common sense way.

TABLE IX

Time Required for Learning Different Materials

(From Reed: *Ped. Sem.*, 1924, 32, 147–55.)

Material	Amount (In Words or Digits)	Time Required for Learning (In Minutes)
Nonsense syllables	200	93
Digits	200	85
Prose	200	24
Poetry	200	10
Poetry	700	91
Poetry	875	98

It is the general outcome of the experimental work on this problem that meaningful material, memorized either logically or verbatim, is acquired much more readily than is non-meaningful material which must, in most cases, be learned word for word. Further, the ease of learning seems to vary directly as the meaningfulness of the material. Table IX, taken from Reed's treatment of the earlier experimental work of Lyon, shows this clearly.

The time required to memorize equal numbers of items of the four different materials decreases as the meaningfulness increases. It will be generally admitted that digits are somewhat more meaningful to most people than are nonsense syllables, and that prose of almost any sort is more meaningful than either. It might sometimes be difficult to determine whether prose or poetry is the more meaningful. Poetry has, however, the advantage of rhythm, and ease of memorizing varies directly with the rhythmic character of the material. This may have been influential in causing the difference between prose and poetry in this experiment; or the particular poetry used may actually have been more meaningful than the particular prose passage compared with it.

There are two other striking features about this table. When equal numbers of words are compared, poetry is memorized nine times as rapidly as nonsense syllables; and when the length of the poetry is extended to 875 words, it is learned almost as rapidly as 200 syllables, although most of the words were longer than the syllables. Clearly the logical or meaningful character of the material is more important than the amount.

TABLE X

Relation Between Length of List and Number of Learning Repetitions
(From Ebbinghaus, *Memory*. Tr. by Ruger by Bussenius, 1913.)

Number of Syllables in Series	Number of Repetitions Necessary for First Errorless Reproduction
7	1
12	16.6
16	30.0
24	44.0
36	55.0

As a further case in point, Reed has shown that the memory span for words in sentences is four times as great as is the span for disconnected words; that familiar prose is memorized in less than half the time required for unfamiliar prose; and that only half as many promptings are needed in learning associated pairs of words as in learning non-associated pairs. The recent experiments of Key and of other investigators point similarly to the importance of meaningfulness.

The great advantage of familiar and meaningful material is largely a result of the widely ramifying associations which this kind of material has with things already known to the learner. It is thus already partly learned before the formal learning period begins. Therefore any significant connections within the material itself or between it and outside familiar contexts is a beneficial factor in memorizing.

Length of List. Ebbinghaus first raised the question of the relationship between the length of the section of learning-material and the speed with which it can be learned. He studied lists of varying lengths and measured learning-speed by the number of repetitions necessary for the first errorless reproduction. The relation between the number of syllables in the series and the number of repetitions taken is shown in Table X. Seven syllables were within Ebbinghaus' memory-span capacity and therefore needed but one repetition. Five times that number of syllables required fifty-five times as many repetitions covering a period of fifteen minutes.

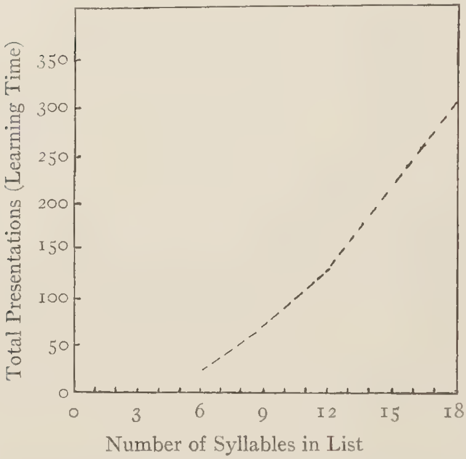

FIG. 80.—Relationship between length of list and time taken to learn. (From Robinson and Heron, *J. Exper. Psychol.*, V [1922], 428–48.)

New data on this problem have been furnished by the already mentioned experiments of Robinson, Heron, and Darrow. They have taken account of the fact that a repetition of a list is not a constant unit, but increases in time required as the length of the list increases. That is, the learner may read over both an 8-syllable and a 16-syllable list once, but the time required for the second is twice as much as that required for the first, although in each case the number of repetitions is 1. They have therefore plotted, not number of repetitions but the total number of syllables presented, (which is the same as total learning time) against the number of syllables in the lists. They obtain the curve in Fig. 80. This curve is positively accelerated, showing that as the lists increase in length the time required for learning is lengthened at an increasing rate. A curve of this general shape would be obtained if Ebbinghaus' results in Table X were plotted in the same units as those used in Fig. 80. The same kind of curve appears for lists of numbers, poetry, and many other materials. It is a general law that "material becomes proportionally more difficult to master as its length is increased" (Carr).

Serial Position. As a sub-problem under the head of the character of the learning material there arises the question whether in any section or list certain parts are generally memorized more easily than certain other parts. That is, do certain positions in the series of items to be learned have any constant advantage independently of their individual character? A long line of experimenters have studied this problem with the result that it is now a well established fact that the first and last positions in a series have a clear advantage. Some have found that the initial position is slightly better than the final position and others have reversed this finding by slight amounts. These small differences in results are usually due to differences in the experimental procedure.

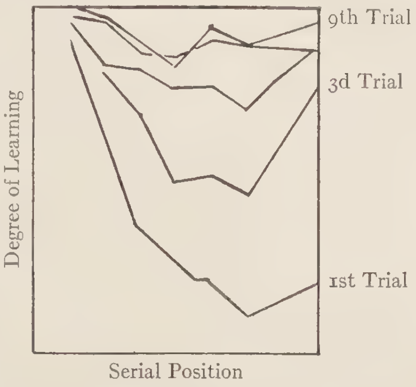

FIG. 81.—Serial position curves. (From Robinson and Brown, *Amer. J. Psychol.*, XXXVII [1926], 545.)

Woodworth and Poffenberger describe an experiment performed in the Columbia laboratory which illustrates well the law of the primacy-finality advantage. Lists of 10 digits each were read to a class of 26 students who were to try to write down each list immediately after it had been read. The results were expressed in terms of the percentage of error at each of the ten positions, with the outcome shown in Table XI. The first and last positions are distinctly superior, with the other positions distributed in between and the middle positions, 4, 5, 6, and 7, are poorest of all. The same facts are shown by a curve from a recent article in which serial-position curves are published for lists of both syllables and numbers in several different lengths. This curve (Fig. 81) shows the percentage of learning at each position in a list of nine syllables at the end of 1, 3, 5, 7, and 9 trials. The same general

TABLE XI

PERCENTAGE OF ERROR AT EACH POSITION IN A TEN-DIGIT MEMORY-SPAN LIST

(From Woodworth and Poffenberger, *Textbook of Experimental Psychology*, p. 71.)

Position in series	1	2	3	4	5	6	7	8	9	10
Percentage of error	1	10	17	23	27	24	24	19	13	2

relationships hold after other numbers of trials and with lists of other lengths. The first position is somewhat better than the last and both of these are better than any of the intermediate positions. The primacy advantage spreads over several items beside the first syllable, while the finality effect is more limited in scope. The form of the curve for serial-position values was hit off unwittingly not long ago by a student who, while learning lists of words, noted the greater difficulty of the intermediate words and remarked suddenly: "Confound it, my mind sags in the middle."

There has been some discussion among psychologists regarding the explanation of the primacy-finality law. It has been argued that the advantage of primacy is a result of the subject's "thinking back" or rehearsing the first part of the list while studying the remainder. Primacy still maintains its superiority when each syllable or other item is exposed for too short a time to permit of such rehearsal. It may be a result of conditions intrinsic to the experimental methods, or it may be that these positions are, as Woodworth and Poffenberger suggest, freer from interference or confusion with other items than are the intermediate positions. Whatever the explanation, primacy and finality (the initial and final positions) of serial position assist memorization, in experiments as ordinarily conducted, to a significant degree.

THE CHARACTERISTICS OF THE SUBJECTS

Individual Differences. The great differences which exist in the learning ability of individuals is one of the first things to attract notice when one examines the learning records of any large number of subjects. Although the learners may all be college students of approximately the same age and class in college and hence as homogeneous a group as one could ordinarily find, some of them will learn several times as much as others in the same learning period. In one experiment in which subjects learned several lists of eight nonsense syllables each, the slowest learner required twenty-four trials while the fastest took but five. The best was thus nearly five times as good as the worst. In comparison with other results this range is not extraordinary. In some experiments, especially when more heterogeneous groups are measured, the best may be ten or more times as good as the poorest. In between these extremes there are many smaller but nevertheless considerable differences. When the records of a large number of subjects are plotted, they are found to follow the form of the normal probability curve.

These individual differences, which are among the most inevitable facts of human nature, are partly an outcome of some of the factors to be discussed later, such as age, sex, and intelligence. They still appear, however, when these factors are held constant. Other conditions, many of them not yet experimentally isolated, underly and produce them.

Memorization and Age. There is no significant exception to the generalization that ability to memorize increases with increasing age from infancy to late adolescence or early maturity. The exact point at which growth stops differs with the material memorized, but the important thing is that memorizing ability, for all materials, grows with increasing age from a lower to a higher point.

Pyle had pupils in both the grades and high school study meaningful prose passages for five minutes. They were then asked questions about the main ideas in the prose studied. The results at each age are expressed graphically in Fig. 82. The curves for both boys and girls rise steadily with age. Not all studies of the relation between age and memorizing ability have found curves as smooth as these or which rise as rapidly. It is, however, an oft-repeated finding that for all memory materials the curves do rise with increasing age. The slope of the curve and the point at which pronounced slowing up begins vary with individual subjects, with the nature of the memory materials, and with the experimental conditions, but the general law of increase in memorizing ability with age is unaffected by these variations.

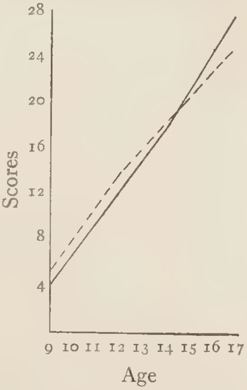

FIG. 82.—Curves of growth in ideational learning. (From Pyle, *Nature and Development of Learning Capacity*, p. 79.) Solid line represents boys' scores, broken line girls' scores.

It is interesting that this experimentally obtained law runs flatly counter to popular opinion, which usually holds that ability to memorize, especially by rote, declines with age. There are certain reasons for this popular opinion. For one thing, adults actually do less verbatim memorizing than younger persons and they lose the advantage of improved technique which is one product of continued practice at memorizing. Further, when confronted with a need for verbatim learning, they are usually not strongly motivated to such work. It does not appeal to them as interesting or worth while and as a result they attack it with less vigor than they bring to more significant work. Young learners can more readily muster the necessary enthusiasm for such learning because, among other things, their training has not habituated them against it. To these reasons must be added the inhibiting effect of one's belief that he can learn less readily than when he was younger. These factors may operate practically to make adults learn less well than children or adolescents. When, however, all learn similar materials under experimental conditions which are as nearly as possible identical, the actually superior memorizing ability of the adults becomes at once apparent, regardless of the nature of the material learned.

It has long been known that learning ability increases from infancy to maturity, but until very recently no systematic investigation had been made of the course of this ability during the later years of maturity. It has often been assumed that memorizing ability declines as maturity advances and that, from the thirties on especially, it becomes very noticeably poorer than it was in early adulthood. Thorndike and his associates have recently published, in a book called *Adult Learning*, the results of a long and careful series of tests of this assumption, which constitute one of the most important experimental contributions of recent years. The ability of adults of different ages up to 45 to learn both rote and logical memory materials was surveyed, with a resulting curve of the form shown in Fig. 83. The curve rises from age 5 to the late 'teens, remains practically flat until the late twenties, and falls slowly thereafter to age 45. At this age the ability is still well above that at any preceding period except the late 'teens.

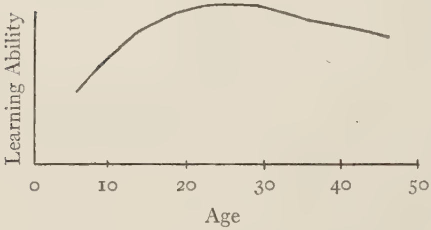

FIG. 83.—The general form of the curve of ability to learn in relation to age. (After Thorndike, *Adult Learning*, p. 127. New York: Macmillan Co., 1928.)

Professor Thorndike concludes that "in general, nobody under forty-five should restrain himself from trying to learn anything because of a belief or fear that he is too old to be able to learn it. Nor should he use that fear as an excuse for not learning anything which he ought to learn. If he fails in learning it, inability due directly to age will very rarely, if ever, be the reason. . . . ." Adults may be expected "to learn at nearly the same rate and in nearly the same manner as they would have learned the same thing at fifteen to twenty. What that rate and manner will be depends upon the general intelligence and special capacities of the individual."

What is the course of the curve beyond age 45 we do not yet know. If we extrapolate to the right of the curve obtained by Thorndike, we see that it will be many years before the curve will have fallen to a point which indicates an equality with the ability of a 10-year old. Few men, in fact, live to so ripe an age as this would require.

Memorization and Sex. At one time it was supposed that the native mental differences between the sexes were large and that memorial differences constituted an important special case of this principle. A large amount of experimental work has been done on the problem of sex differences in memory, but the results have been so lacking in uniformity that interpretation is difficult. In most experiments differences between the sexes have been found, but the most striking fact is that these differences are characteristically small and highly variable in direction. The curves in Fig. 82 show the usual smallness of sex difference, and are even more consistent in direction than is typically the case.

In certain experiments one sex has been found to excel the other with some consistency, but this result seems to be a function of training and interest rather than of native differences. For example, boys excel girls in ideational learning when the material is scientific in nature, while the girls are superior when the ideas learned are about furs and fur-bearing animals. In rote memory, where training and interest are more nearly equal, no sex differences appear. Many experiments have yielded similar results. It is hard to make a valid generalization which will cover all the results upon the problem, but there is at least much support for the statement that sex differences in learning ability are small and variable and seem to be a function of the general experimental conditions rather than of inherent mental conditions.

The Influence of Sensory Modality. It is possible that the sense department to which the memory material is presented might influence the speed of memorization. In experiments on memory the three most important modalities are vision, audition, and kinaesthesis. A list of syllables may be read by the subject (vision), or it may be read to him by the experimenter (audition). In either case he may articulate each syllable completely, partially, or not at all (kinaesthesis). Likewise, combinations of all three modalities may be employed. Many are the experimental changes which have been rung upon this theme. Now vision and now audition has been declared superior, but always by relatively small amounts. With regard to these two modalities, the net result seems to be that neither can claim an inherent superiority. Which one gives best results is a function of the habitual usage of the subject and the particular material to be mastered.

It must be recognized that we cannot wholly isolate a sense modality. An experimenter may present his memory material to a subject's vision, but naught prevents the subject from translating the material straightway into auditory terms, and vice versa. Consequently, large differences, even if obtained, would be difficult to interpret.

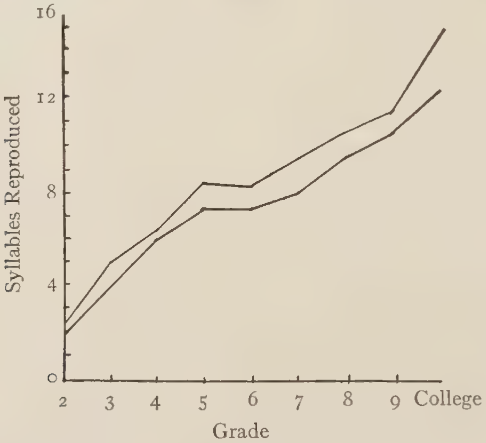

Fig. 84.—Learning with full and restricted articulation. Top curve is full articulation, lower curve is restricted articulation. (After Barlow, *J. Exper. Psychol.*, XI [1928], 307.)

The rôle of articulation is likewise, perhaps, a function of the customary usage of the subject. Recently some results upon this problem have been published indicating that, for whatever reason, restricted articulation is detrimental to learning. The experimenter had school pupils from the second to the ninth grade, and college students, learn lists of 20 nonsense syllables each. The syllables were presented visually four times each. Under one condition the subjects were instructed to use tongue and lips in repeating the syllables as they were presented; under the other, each subject was asked to refrain from saying the words over to himself and to assist himself in this by holding a pencil crosswise between his teeth. This method insured at least a restricted articulation. The number of syllables reproduced under the two methods, as represented in Fig. 84, shows a clear superiority for the learning with unrestricted articulation. The two curves are also illustrations of the increase in learning ability with age.

The Influence of Intelligence. It is almost a truism that the dull learn less well than the bright. Intelligence has, in fact, been defined as the ability to learn. When, however, we correlate the learning scores of a group of subjects with their intelligence scores, the coefficient of correlation is seldom high. Even were the definition given correct, the correlation would be fairly low because of such artifacts as errors in the measurements of both intelligence and learning. One thing also which must be remembered when interpreting the obtained coefficients of correlation is that they have been worked out almost wholly by using measures of very specialized learning and upon relatively highly selected and homogeneous groups. Had we a general index of ability to learn all possible materials, the correlation with intelligence might be much higher.

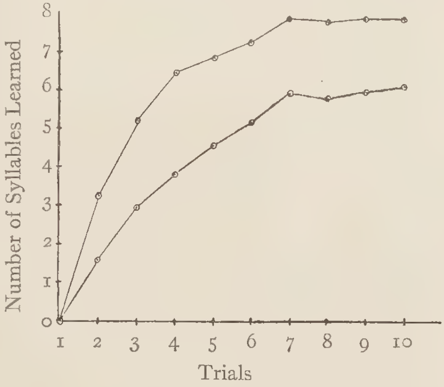

Fig. 85.—Memorization curves of two groups of different average intelligence.

If we compare two groups of college students, one with a high intelligence score and the other with a lower test score, with regard to their ability to learn nonsense syllables, we find that the higher group consistently learns more than the lower in equal amounts of time. In one experiment, a group of college students with a mean Army Alpha score of 182 and another with a mean score of 120 learned 8-syllable lists, giving ten repetitions to each list. The amount learned at each trial is shown graphically in Fig. 85. The high group maintains consistently a higher degree of learning at each successive trial. The student will note that the curves have the typically negatively accelerated form.

We may obtain differences by the methods of group comparison, when coefficients of correlation over a similar range are low. Such differences, however, together with the known factors which operate to decrease most of our experimentally obtained coefficients of correlation between intelligence and learning, warrant the generalization that, over any wide range of talent, ability to learn varies proportionally with test intelligence.

The Influence of Muscular Tension. It is usually assumed that vigorous mental work is accompanied by a heightened muscular tension. It is an interesting question whether this tension hinders or helps the work. A recent experiment gives a definite answer. The subjects learned lists of nonsense syllables while squeezing a dynamometer (a device for measuring strength of grip) with a constant and continuous pressure with each hand. There was an advantage of 13 per cent for this tension condition over the non-tension or normal condition of learning. Further, as Fig. 86 shows, the subjects improved more in speed of learning under the tension than under the normal condition. As they learned successive lists from one to ten the number of repetitions required became significantly smaller in both conditions, but the decrease was more pronounced under tension. It thus appears that the muscular tension accompanying learning exerts a facilitating or reinforcing influence.

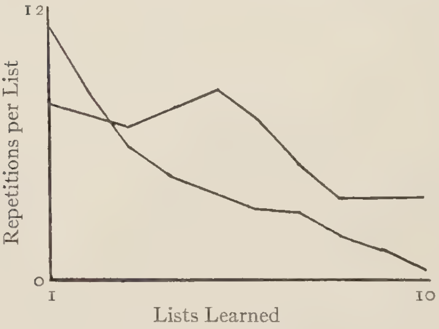

FIG. 86.—Practice curves of learning time. (From Bills, *Amer. J. Psychol.*, XXXVIII [1927], 235.)

Motivation. Other things being equal, the rapidity of learning is proportional to the motivation of the learner. This statement can be made with more experimental assurance in the field of motor-learning than in that of memory proper, but there is a sufficient body of experimental fact to indicate strongly that it holds for memory also. Experimentally we take motives to be such general conditions as hunger, desire for praise, avoidance of pain, and the like, and learning under these conditions is compared with that under no other motivation than is provided by the general experimental situation. The introduction of special motives has in most cases a definitely beneficial effect upon learning.

Intention to Learn. In most experimental work on learning an intention on the part of the subject to learn is assumed. This intention to learn is closely related to motivation. Much of the learning of everyday life is, however, incidental and unmotivated. One picks up information without intending it. This incidental learning is of items which come within the range of attention but which are not focally attended to. What and how much one learns in this way are functions of too large a number of factors to warrant enumeration here. The significant point is that one may be thus incidentally exposed to material many times, but if there is no intent to learn, with its accompanying focal and active observance, the exposures are very ineffective. In point is Woodworth's account of the foreign student in a Swiss laboratory. The experimenter exposed to him for many times a series of nonsense syllables, supposing that the student knew he was to learn them. It turned out that the student had not understood. He carefully observed each syllable as it appeared, but made no attempt to learn them in connected series. When tested after many exposures, it was found that he had learned almost nothing. Many systematic experiments support the implication of this incident that the intention to learn is highly important. This intention operates not by any influence of an "intention" as such on learning, but by making the subject observe closely and react directly to the material. Mere frequency of repetition is not enough. There must be frequency with attention to or noting of the things to be learned with intention to connect or learn them.

METHODS AND CONDITIONS OF STUDY

Under this head come such factors as the methods by which memorization is attempted and the conditions, such as guidance, under which memorization is done. These factors are not coordinate with the characteristics of the subjects or of the materials learned. They have to do, rather, with the way in which and the condition under which a given subject attacks a given material. The search is, of course, for the optimum methods and conditions for this attack.

Distribution of Time. A student may spend whatever time and repetitions he devotes to the learning of anything in either one of two general ways. He may study consecutively for the whole time, going over the material with repetitions which follow each other immediately. This is called *massed* or *unspaced* practice. Or he may study for a given length of time, then introduce a rest period during which he either rests completely or indulges in a different activity, then study for another period, and so on. This is called the *method of temporal distribution* and the various repetitions are said to be distributed.

There has emerged one well-established law from the numerous studies in which these two methods have been compared. This law states that some form of distribution is always superior to massed practice and is called the law of distributed practice. It holds for virtually all experimental techniques and for all subjects and materials.

It is desirable to work out sublaws which shall state the most advantageous specific schemes of distribution, and much experimental work has been devoted to this end. An infinite number of schemes of distribution is possible, but all are affected by the manipulation of certain variables, mainly length of study period, length of rest interval, and regularity of introduction of each. (1) A learner might, for example, maintain a constant rest interval and regularly preface each interval by a study period of any possible length. (2) Or he might keep a constant study period but regularly interpolate a rest interval of any possible length. (3) He might, on the other hand, vary both the length of the study and rest periods, using perhaps long study periods and short rest intervals in the early part of the learning and the reverse in the later stages. Running through these there is apt to be a fourth variable, the total time over which the combined study and rest periods last.

We shall cite a few typical experiments upon the influence of these variables. It has been found that (1) and (2) are closely interrelated. In one experiment the subjects learned 14-syllable lists to sixteen repetitions each, taking either 1, 2, 4, or 8 repetitions per sitting and allowing rest periods of 1, 2, 3, or 4 days. One reading at each sitting gave the best results. The most favorable rest interval was two days when one or two repetitions per sitting were given, while the four day interval was best when four or eight repetitions were used. Thus the optimum length of the rest period is roughly proportional to the length of the learning period. There is undoubtedly an upper limit to this principle.

An early experiment by Jost illustrates the use of a constant rest interval with a variable study period. The distributions used and the results obtained are presented in Table XII. They are clearly in favor of short and numerous study periods.

The evidence upon the effect of varying both study periods and rest intervals is less imposing and more equivocal. In an experiment on the learning of French-English vocabulary lists, the subjects used study periods which decreased gradually in length and these were separated by rest intervals which grew progressively longer. This arrangement was compared with a control schedule in which both study periods and rest intervals were constant. Decreasing study periods with increasing rest intervals were superior to the control condition, but we do not know whether the variation in study period or in rest interval was more effective in producing the results.

From the standpoint of effective learning it is probable that short rest intervals between fairly long study periods in the early stages of learning, and the reverse of this in the later stages, will give the best results. The student should remember, however, that this applies only when he is studying the same material throughout. It does not necessarily apply when he is working at progressively changing material such as successive sections of an assignment.

TABLE XII

Three Distributions of Twenty-four Readings of Nonsense-Syllable Lists

(After Jost, *Zeitschr. f. Psychol.*, 1897, 14, 436–472)

Distribution	Total Scores	
	Subject 1	Subject 2
8 readings a day for 3 days......	18	7
6 readings a day for 4 days......	39	31
2 readings a day for 12 days......	53	55

The problem of the explanation of the general law of distributed practice is an interesting one and a review of some of the suggested solutions will be instructive. (1) The rest intervals might give opportunity for review; hence the benefit from distribution is really a result of unmeasured amounts of informal practice. This explanation is unlikely since distribution is beneficial not only when the subjects insist that they have not rehearsed but when they have been kept busy at something else during the interval. (2) The poorer results from massed practice might result from fatigue engendered by continuous study. However, distribution is advantageous when the subject has previously been greatly fatigued and when the length of the massed practice is relatively so short that fatigue is unlikely. (3) It is possible that motivation is higher when working periods are short than when they are longer. There are certain objections to this but it is a possible, though very partial, explanation. (4) It has often been assumed that the mechanisms involved in the fixation of acquired material perseverate or continue active for a time after the learning proper ceases, thus "setting" the material more firmly by unconscious practice. When learning is massed, the advantage of this perseveration is lost. Present neurological opinion seems to be against any such perseveration theory. In point of fact, so little is known regarding psychoneural mechanisms that this need not influence us unduly against the theory, which has the great advantage of being universal in its application to all types of learning and to all living organisms. It may be offered as a possible but unproved explanation of the efficacy of distribution.

Whole and Part Methods. The question whether learning materials may best be studied piecemeal or in wholes has invited serious experimentation for forty years. At first investigators believed that they had arrived at clear evidence in favor of the whole method. Later findings have contradicted the earlier ones and the present general conflict of results permits no confident generalization. Which method is superior is a function of the nature of the material, the age, training, and motivation of the subjects, and doubtless of other factors. It is probable that, as one writer has suggested, the problem as usually stated is too large for a single generalization.

The Influence of Recitation During Memorizing. From the standpoint of recitation there are two possible methods of study. One may read and reread the material until he has almost certainly learned it and then try to recite it; or he may attempt to recite frequently during the learning-period itself. An experiment by Gates has yielded clear results in favor of the latter method. Sheets of paper containing the material were placed before the subjects who, in the recitation conditions, were to study for certain lengths of time and to try to recite for certain other times, prompting themselves when necessary. The results are summarized in Table XIII. The figures show the percents recalled immediately at the end of the learning period.

This table shows that learning tends to vary directly with the percentage of the total learning time devoted to recitation. The advantage of recitation is more pronounced with the nonsense syllables, because in learning meaningful material one is constantly organizing the meanings as he goes and this involves running back over parts previously read, thus affording a kind of progressive attempt at recitation as one reads, and at the same time keeping one's interest at a higher level. Even with the biographies, however, time spent in definite efforts at recitation is profitable.

It has been found to be better to intersperse readings and recitations rather than to group them. It may be pointed out that the experiments on this problem have been complicated by the mixture of recitations and promptings when the subject could not recite. Thus the method of recitation is really recitation plus prompting. This suggestion does not affect the results themselves, but it assists in their interpretation.

The efficacy of recitation is readily explainable. (1) The learner is constantly practicing the recall of the material in the form in which it is finally to be reproduced and used. (2) It provides him with progressive information about his progress and this knowledge is a motivating factor. (3) He is discovering which parts are hard and which easy early enough to permit a proper distribution of effort over the material.

TABLE XIII

RECITATION VERSUS NO RECITATION IN MEMORIZING

(From Gates, *Recitation as a Factor in Memorizing*, 1917)

	MATERIAL	
	16 Nonsense Syllables	5 Short Biographies (170 Words)
All time devoted to reading	35	35
1/5 of time devoted to recitation	50	37
2/5 of time devoted to recitation	54	41
3/5 of time devoted to recitation	57	42
4/5 of time devoted to recitation	74	42

The Influence of Rhythm. Rhythm has been found to be a significant aid to learning. It has even been shown that a suppression of rhythmic vocalization almost completely blocks the learning of some individuals. The particular rhythmic grouping which is most advantageous varies with individuals and apparently with nationalities, but this does not affect the generalization that ease of learning varies directly as the rhythmization of the material. This factor may be viewed either as a method of learning, as a characteristic of the material, or as a characteristic of the learner. It has been treated as a learning method because rhythmization may be adopted as a technique regardless of specific materials or of the specific characteristics of the learner.

The Influence of Guidance. The effect upon maze-learning of assistance or guidance from the experimenter has been systematically investigated. Less attention has been given to the influence of guidance upon memorizing, partly because few memory materials lend themselves to such assistance However the recent work of Waters and of Sullivan, in both of which ideational learning of the problem-solving kind was studied, bear upon the general problem. In Waters' experiment the problem consisted in presenting to the subject seven beads upon a wire from which the subject and the experimenter drew, alternately, either one or two beads. The subject drew first and his task was to draw so as to take the last bead. This problem could be complicated by increasing the number of beads used and the number of beads allowed per draw. A demonstration of the correct method of drawing to win was detrimental to learning, while a short and concrete statement of the principle involved, information about and compulsory correction of errors, and calling the attention of the subject to the significant aspects of the problem were all beneficial. In general, tuition was more effective when introduced at the beginning of learning than later in the process.

Sullivan used memory material through which ran common elements that could be summarized in a generalization. She compared three different learning methods. In Method I no instruction was given; in Method II the subject was told to search for a generalization; and in Method III the generalization was given outright. The likelihood that a generalization will be reached increases from Method I to Method III. Here again guidance in the form of a stated principle is effective.

Both of these experiments have more important implications for concept formation and allied functions than for memory. They evidence, however, the indeterminate character of the boundary between memorial and rational processes. In the case of memory they permit the statement that in so far as a possible generalization or general principle runs through the material to be learned, guidance in the ways described is beneficial. In this connection the facts regarding verbatim versus meaningful material should be recalled. It may also be noted that one of the values of the method of recitation during learning lies in the fact that it shows the subject where the hard parts of the material are and thus gives a kind of guidance.

THE INFLUENCE OF TRAINING UPON MEMORIZING

The Influence of Practice. It is a frequent experimental observation that continued practice at memorization is accompanied by a pronounced decrease in the number of repetitions or the amount of time required to learn that particular kind of material, at least. Fig. 10, which is taken from Bills' work on tension, is an example of the influence of continued practice. It shows that the number of repetitions required for learning grows steadily less as successive lists are learned, especially under the tension condition. Other experiments likewise assure the conclusion that memorizing ability is susceptible to a very considerable increase by training and that, under certain conditions, this improvement spreads to other than the materials used in this training.

Associative Inhibition. The positive effect from practice holds primarily when the same type and organization of material is used throughout. The mere fact of continued learning does not, of course, guarantee increased effectiveness. Particularly is this true when the successive materials are of such a nature as to be subject to the influence of associative inhibition. Early in the development of the experimental study of memory, Müller and Schumann formulated the law that when any two items have become associated it is more difficult to form a new association between one of them and a third item. This law of associative inhibition operates when the initial two items are connected with each other to a moderate degree. It is less in evidence when they are either very weakly or very strongly connected.

The Nature of Improvement. Improvement in memorizing may be viewed as the result of an increase in a general power or faculty called "memory," or in the acquisition of improved learning methods. It is a generally accepted interpretation that improvement is of the latter nature. Gates and Taylor have very cogently shown this to be the case for immediate memory for digits. They equated two groups of children in scholastic maturity, sex, age, intelligence, and in immediate memory. The experimental group was given practice at immediate memory for digits on each of 78 days during a period of 4.5 months. This resulted in a marked gain in ability. The other group, which served as a control, was better after 4.5 months than at the beginning, but was clearly inferior to the trained experimental group, thus demonstrating that the better memorizing of this group was a result of the training and not of other and unmeasured factors such as inner growth. After another 4.5 months, however, during which no practice was given either group, they were equal not only in immediate memory for digits but in other immediate memory tests. After 3.5 additional months without practice both groups were given 22 days of intensive training with digits. At the end of this period the groups were still equal. The original 78 days of practice had given the experimental group no permanent advantage. Presumably the improvement which they showed was not of fundamental memorial capacity. It consisted rather in the acquisition of special techniques, adjustment to and familiarity with the experimental situation. These are transitory and unstable factors since after 4.5 months they had disappeared to show no measurable effects.

This conclusion is still further supported by a study of so-called "memory experts" or phenomenal memorizers who perform almost incredible memorial feats. In most, if not all, of these cases the extraordinary performances are a function of special methods of grouping the material, of motivation, and similar factors. In these cases no improvement of general capacity can be found, and in many instances such individuals are of distinctly inferior intelligence. The whole secret of their "expertness" lies in their special techniques for dealing with certain types of material.

IV. THE CURVE OF RETENTION

The second fundamental problem of memory is that of retention. We wish to know what happens to the acquired material from the moment that the learning period ends until some indefinite future time. That is, when we plot amount retained against the intervals of time from the end of learning onward, what form will the curve have and what factor will affect this form? We have no way of measuring retention directly, but must depend upon the indirect measures afforded by recall, saving, and recognition scores. We assume that the material is retained independently of these measures, but lacking more direct measurement we cannot tell how complete a picture such indirect ones give us. They are, however, the only ones experimentally available and they are, as well, the only measures of any practical significance.

The Ebbinghaus Curve. It is possible to plot the memorial history of any acquired material by making retention tests at successive points in time and then plotting the amount retained against the time. This gives a retention curve or, conversely, a curve of forgetting. The form of this curve of forgetting was first worked out by Ebbinghaus using the saving method with nonsense syllables. The classical Ebbinghaus retention curve (Fig. 87) falls very rapidly over the time immediately following learning and then at a diminishing rate, thus giving a negative accelerated curve. The units on the horizontal axis of Fig. 87

are not small enough to permit the graphing of the results after a twenty minute interval, but over this period 42 per cent of the syllables had been lost. After two days 72 per cent had been forgotten and from this point on forgetting was very slow.

Many later investigators have obtained retention curves of the same general form as that of Ebbinghaus. The absolute amounts forgotten vary with a number of factors which we shall presently discuss, but it is a general finding that with adults forgetting proceeds most rapidly in the time immediately succeeding learning and more slowly thereafter. A few retention curves do not show this, but their failure to do so is attributable to the fact that no tests of retention were made until a relatively long period after the close of learning. Whether forgetting is ever complete we do not know. Forgetting curves approach the abscissa as a limit but they never quite reach it, or at least we are not sure that they do.

Reminiscence. The classical Ebbinghaus curve was, until recently, thought to represent a universal principle. The experimental work of the last few years has produced, however, certain striking exceptions. These exceptions occur under rather narrow conditions, but they are nevertheless highly important. The first distinguished failure to obtain the typical curve occurred in 1913, when Ballard published retention curves which showed, instead of the customary rapid drop during the first two or three days of no practice, an initial rise during this period, followed by a decline. He named this improvement-without-practice phenomenon reminiscence, contrasting it with obliviscence, the usual result. This unexpected finding has since been verified by at least five independent investigations, so that it must be considered an authentic phenomenon.

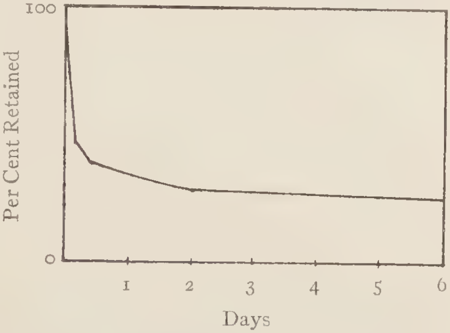

FIG. 87.—The Ebbinghaus curve of retention

The conditions under which reminiscence occurs have been but incompletely worked out, although of some of them we can be fairly certain. The phenomenon can occur, of course, only with partial learning. If learning were to complete mastery, there would be no opportunity for improvement of this kind; a recall of more than 100 per cent of the material would be an absurdity. It is found, also, to any considerable degree only with children. This dependence of reminiscence upon age is shown well in Fig. 88, which is taken from a paper by Williams. He had large groups of individuals of different ages partially learn selections of poetry. Each age group was subdivided into five groups, each one of which was tested for retention after a different interval. The intervals used were 1, 2, 3, 5, and 7 days. The retention curve of the 9-year olds is 14 per cent higher after one day than at the close of learning. It falls from that point but is still above 100 per cent (which is the amount recalled at the close of the learning period) after three days. The curve of the 12-year-old group shows reminiscence, but to a less pronounced degree, while those of the 16- and 21-year olds show none, and that of the latter group has the typical Ebbinghaus form. It is clear that with poetry as material the degree of retention is inversely related to the age of the subjects. This agrees, also, with Ballard's earlier results.

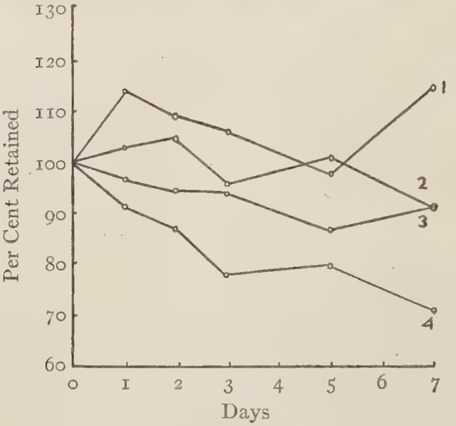

Fig. 88.—Curve of retention for poetry. Curves 1, 2, 3, and 4 are for age groups 9+, 12+, 16+, and 21+, repsectively. (From Williams, *J. Exper. Psychol.*, IX [1926], 373.)

We must specify further the conditions of reminiscence, for partial learning and age are not the sole factors. Both of these may be present, but no reminiscence will result unless the material learned is of a connected sort best represented by poetry. Williams' retention curves for lists of abstract words show no hint of reminiscence. All have the classical form and none shows any relation to age.

These three factors, at least, condition the appearance of reminiscence. There is small doubt that others yet unmeasured are among its conditions. It has been suggested, for example, that a more or less unintentioned rehearsal during the interval may account for the better recalls after the lapse of time. This is possible, but it is difficult to understand why this rehearsal should vary inversely with age, as it must do if it is to explain the phenomenon. It can be urged that the materials used appealed more to younger children and hence were more likely to be rehearsed. This again is possible, but Ballard and Williams used several different poems and it is by no means certain that all were of a kind to appeal only to the younger age-groups. Rehearsal is a possible but doubtful explanatory factor. The plain fact is that we know some of the conditions under which reminiscence appears, but not its basic explanatory conditions. These offer an open field of research, for few facts in the field of memory are as intriguing as reminiscence.

V. THE PRIMARY CONDITIONS OF RETENTION

So ubiquitous is forgetting that it is often taken for granted and consequently the need of an explanation for its occurrence is unrealized. In spite of its great universality, however, its explanation offers a fundamental problem to experimental psychology. It is sometimes stated that forgetting is the result of dropping out of nerve pathways in the brain. This may be true, but we actually know nothing about what happens to nerve pathways when one forgets. To offer any changes therein as explanations of forgetting is but to restate the problem in neural terms.

There are two conditions of a fundamental character which provide the only explanation of forgetting thus far experimentally discovered. These two primary conditioning factors are retroactive inhibition and alteration of environmental and contextual factors.

Retroactive Inhibition. Retroactive inhibition, first investigated by G. E. Müller in the early years of the present century, refers to the disintegrating influence exerted by a subsequent learning activity upon the retention of a material learned antecedently. Thus, if a student studies a poem for thirty minutes and immediately thereafter turns to a half hour's study of another poem, his ability to recall the first poem will be less than it would have been had he permitted a rest interval of no learning activity to intervene between learning and recall. The difference between the recall of any material after such a no-learning period and the recall after a similar period of study is the amount of retroactive inhibition, or the disintegrating influence which the interpolated study has exerted upon the recall of the material first studied. The experimental procedure in studying retroaction is of this general form, when the numbers stand for learning materials of whatever kind:

Rest Condition:	Learn (1)	Rest	Recall (1)
Work Condition:	Learn (2)	Learn (3)	Recall (2)

The difference between Recall (1) and Recall (2) is the gross amount of retroactive inhibition. The relative amount is this difference divided by the score under the rest condition. In the work condition the material first learned is called the original and that learned second the interpolated material. Any kinds of material whatever may be used in this experimental framework, of course.

The experimentally obtained amounts of retroactive inhibition vary from near zero to near a hundred per cent. The amounts appearing in any given experiment are functions of several factors. One of these factors is the degree of similarity obtaining between the interpolated and the original learning materials. Logically this similarity may vary from a complete identity, in which case the interpolated learning is merely continued practice of the original material, to zero similarity, in which the two have nothing whatever in common. Experimentally it is difficult to quantity similarity sufficiently to permit an accurate statement of how much of it one is actually using. Logically, however, and probably psychologically, French is more like German or Italian than it is like mathematics or physics, which again have more in common with each other than with economics. Likewise two lists of nonsense syllables resemble each other more than do a list of syllables and a list of numbers, and these again are more similar than are a list of numbers and a poem. In this fashion, using materials which can be ranked with respect to logical similarity, it has been shown that there is a positive relation between degree of similarity and amount of retroaction, provided only that the similarity employed stops well short of identity.

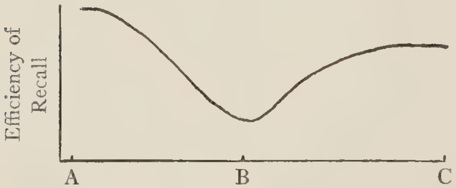

FIG. 89.—Similarity and efficiency of recall. (From Robinson, *Amer. J. Psychol.*, XXXIX [1927], 299.)

The probable relation between similarity and retroaction has been expressed in the hypothetical curve of Fig. 89, in which efficiency of recall is plotted against degree of similarity. Toward the center of the curve where efficiency of recall is lowest, retroaction, of course, is highest; and toward the identity and zero ends recall is high and retroaction low. This theoretical law is supported by what seem like valid inferences from several experiments, and by logical analysis of the memorial events of everyday life. It yet lacks experimental verification.

In a recent experiment aimed at this problem similarity has been quantified in terms of the identical items in the two halves of a memory span. The halves could be wholly identical or could have any desired number of identical items. In a span of 12 consonants, for example, any number from 0 to 6 could be the same in each half. With such a span, in order to verify the theoretical law of Fig. 89, retention should be highest when both halves are identical and when they are wholly different, while with 2, 3, and 4 identical, perhaps, it should be lowest. This was not the experimental finding, however. In two minor divisions, or cycles, of the experiment the curve turned up at the one identical condition, but the general outcome is expressed in Fig. 90 which shows that retroaction and similarity are inversely related. The memory span technique is hardly typical of learning materials and methods in general, however, and this finding may represent one important limiting case of a general principle, rather than its negation.

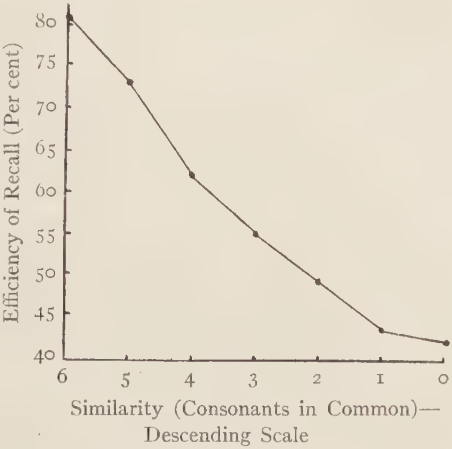

FIG. 90.—One relationship between similarity and retroactive inhibition. (From Robinson, *Amer. J. Psychol.*, XXXIX [1927], 311.)

A second factor affecting the degree of retroactive inhibition is the temporal point at which the interpolation occurs. The interpolated material may be introduced immediately after the original learning, just prior to recall, or at any desired point intermediate between learning and recall. The influence of this factor is far from being completely explored, but if we combine the results of all of the experiments it is a fair inference that for most materials the positions just after learning and just before recall are the ones at which interpolated learning exerts the most inhibitory effect, although this cannot be laid down as proved, by any means.

A third factor in retroaction is the degree to which the original material has been learned. In an experiment using nonsense syllables lists of 8 were learned to 6, 11, 16, 21, and 26 repetitions, and under the work condition a standard interpolation of a similar list learned to eleven repetitions was introduced. With the larger numbers of repetitions overlearning was very great. The relative amounts of retroaction, measured in terms of both recall and saving scores, (Fig. 91 varied inversely as the number of presentations given the material to be learned. In terms of recall score, however, there remained 46 per cent of retroactive inhibition even with 26 learning repetitions. The corresponding retroaction when retention was measured in terms of saving was but five per cent. The amount of inhibition thus differs with the method used in measuring retention as well as with degree of learning.

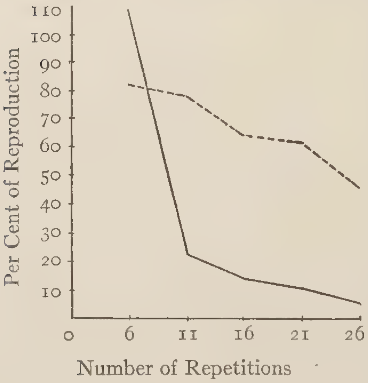

FIG. 91.—Degree of learning and retroactive inhibitions. Solid line represents saving scores, broken line recall scores. (From McGeoch, *Amer. J. Psychol.*, XLI [1919].)

In actual life one can never, short of a psychological vacuum, escape the disintegrating influence of interpolated experience. Between any given experience, formal or casual, and the later recall thereof, progressively accumulating interpolations of experience occur. Within such a series each new experience serves as interpolated material to inhibit the recall of those preceding it. So powerful is this blocking effect that it becomes a marvel, not why we forget so much, but why we remember anything at all. The answer to this marvel lies in the factors above discussed. When similarity is not present in the most inhibiting degrees, when the point of interpolation is not unfavorable, or when the degree of learning of the original material has been great, then we retain to some significant degree. When, on the other hand, similarity, point of interpolation, and degree of learning are favorable to retroaction, we forget. That forgetting is not a matter of passive decay but an active inhibition of the old by the new is indicated, also, by an experiment in which retention was studied after equal intervals of sleep and waking. The subjects recalled more than twice as many syllables after intervals of sleep as after intervals of waking. During sleep, of course, little new stimulation occurs to block the recall of the material learned just prior to the period of sleep.

The term retroactive inhibition is, unfortunately, open to misinterpretation on the part of those not clearly acquainted with the facts. It is sometimes erroneously taken to mean that the interpolated material actually does something to the previously learned material. The exact operation of the interpolation is at present a worth-while research problem We know little about it, but it is reasonably certain that the interpolated learning does not jump backward to do anything to the material which it is said to inhibit. Certain it is that in some manner yet unknown it serves to prevent the recall of such material. According to the perseveration theory, previously mentioned as a possible explanation of the law of distributed practice, the interpolated learning prevents the perseveration of the neural mechanism immediately following the learning period. This perseveration is really a kind of added practice without effort or intention on the subject's part and serves to 'set' still more the nervous basis of the memories, if no interference occurs to stop it. This is a possible explanation for retroaction as well as for distribution of time. A second theory assumes that parts of the interpolated learning activity transfer to the other and the two become confused, thus leading to a poorer recall of the original material. There are facts which may be interpreted in support of either theory and some which definitely favor only one. For example, Whitely found that the arousal of an apperceptive system prior to recall was distinctly inhibitory, while such a system aroused immediately after learning had a much less marked effect. This would favor the transfer rather than the perseveration theory, since on the latter assumption the time just after learning should give the greatest inhibition. With other types of interpolation, however, the latter point has given a large degree of inhibition. No decision can be made between the two theories until further experimentation has clarified the issues. At present it seems that either one or both may explain the facts of retroaction.

Altered Environmental Conditions. The second primary causative factor in forgetting includes altered environmental or contextual conditions of whatever kind. The influence of such alteration has been very incompletely explored, but the inference that it is coordinate with retroaction as an explanatory factor seems sound. Everything which one learns has, during the learning period, two contexts. One includes all possible external stimulating conditions such as the room in which one is, with all of its contents and characteristics; the book one reads, or the lecturer one hears. The other covers all intraorganic conditions, such as the state of one's health, fatigue, hunger, posture, and the like. One may but little note such factors as he learns but they are inescapably present as the general environment or background in which or against which the learning activity must proceed.

At least in the initial stages of learning, the individual is forming associations, not only between the parts of the material which is being learned, but also between these and manifold features of the extra- and intraorganic environment in which the learning is being done. If he has carried the learning only to the threshold, he will often find it more difficult to recall the material in a new place than under the old conditions of its acquisition. Students sometimes object to taking a final examination in a room other than the classroom in which the course was conducted, on the plea that they can recall less well under the new conditions. Likewise one often finds that recall is best when he works under uniform conditions and at his familiar desk; that is, under the conditions in which he acquired the knowledge he now wishes to use. Similarly when one desires to reinstate such facts as names and events, he often finds a return to the scene of his acquisition of such knowledge advantageous.

It even appears that a complete alteration of environmental context may prevent the functioning of whole systems of knowledge. Carr, in his *Psychology*, cites an incident which well illustrates this statement. A missionary who had learned to speak Chinese with fluency during several years of residence in that country found, on his return to an English-speaking country, that his mastery of Chinese was disappearing, and finally he became unable to converse in the language at all. Later, when asked to return to China, he accepted only with trepidation, lest the long grind of language acquisition would have to be gone through again. On his return, however, to the surroundings under which he had learned the language, he found to his great surprise that his old mastery returned almost at once.

That the context affects learning and retention has been shown experimentally by a study of the influence of various word-contexts upon the acquisition and recall of logically unrelated pairs of words. A word-context which is logically related to the response word of a pair exerts a beneficial influence upon learning and its removal or alteration at the time of recall is detrimental. This and other experiments indicate that one learns, not only the specific material which he is attempting to learn, but also to some extent the environmental setting in which the learning activity is carried on. It is probable that freedom from environmental connections of this sort is attained only when the learning has been carried well beyond the threshold. Much of the forgetting of everyday life results from a lack of the appropriate stimulus—the right environmental context. In spite of retroactive effects much knowledge is recallable if the proper stimulating conditions or contextual setting are present.

Little has been said about the influence of altered intraorganic conditions because we know little about the exact effects of such alterations. We know, however, that such conditions do alter, and casual observation and logical inference conspire to support the assumption that such alterations must affect recall. The influence of altered context must be much more thoroughly explored before its exact operation can be described. It is offered here as a very probable cooperating factor with retroactive inhibition.

These two factors, retroactive inhibition and altered environmental stimulation, cooperate to block the recall of huge portions of one's past acquisitions. With interpolated experiences interfering with the recall of previous ones, and with the frequent shifts of environmental stimulation to which the human organism is subject, it is astonishing that we remember anything. When we do succeed in reinstating past acquisitions, it seems to be because the factors affecting degree of retroaction are favorable enough to permit it and because the fortunate stimulus, or proper context, is present either directly or through indirect associative connection.

VI. THE SECONDARY CONDITIONS OF RETENTION

There are numerous other factors which affect retention but which are less fundamental than the two we have been discussing. A study of these secondary factors provides the setting in which the primary conditions operate and serves to specify further the degree of their effectiveness. They may be treated briefly since the general nature of most of them has been discussed under the head of memorizing.

THE METHODS OF MEASURING RETENTION

The degree of retention, as experimentally measured, varies with the method of measurement. The relative positions of five different methods (the three chief methods and two modifications) are shown in

Fig. 92. Four of the methods stand consistently in the decreasing order: recognition, reconstruction, written reproduction, and anticipation. The saving method yields a curve which cuts across those for reconstruction and written reproduction. This method gives relatively better retention after longer than after shorter intervals. This fact of variation with the method of measurement is an illustration of the statement previously made that we can measure retention only indirectly. The available indirect measurements give different results. All may be treated as if they measured an unknown but constant degree of retention residing within the organism and independent of the measurements, or as if retention itself is wholly given in and expressed by the measurements. For the purposes of experimentation

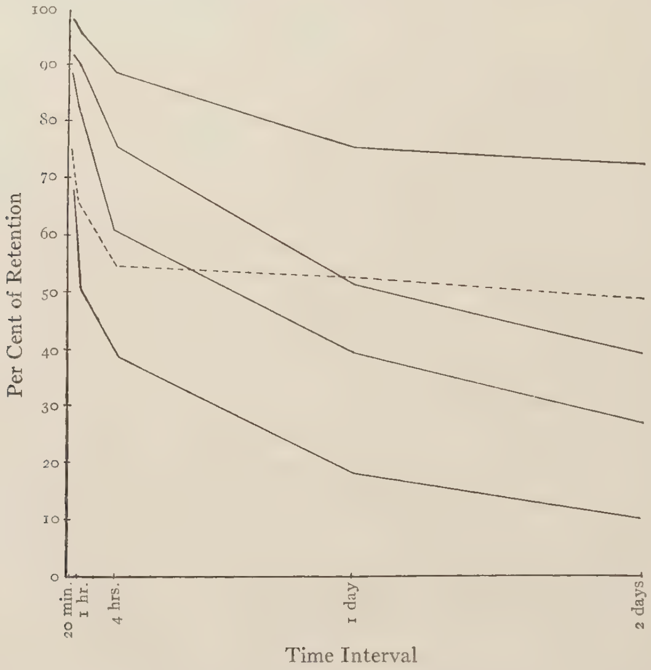

FIG. 92.—Retention curves yielded by different methods of measurement. (From Luh, "The Conditions of Retention," *Psychol. Monograph*, XXXI, No. 142 [1922], 21.) In descending order on the graph, the solid lines represent the methods of recognition, reconstruction, written reproduction, and anticipation; broken line represents relearning.

we act as if the latter were the case, although from the wider standpoint of a systematic interpretation of the data this is a circumscribed and halting assumption.

THE CHARACTER AND LENGTH OF THE MATERIAL

Meaningful versus Non-meaningful Material. Meaningful material is better retained than non-meaningful material, as well as easier to acquire. In so far as its meaningful character implies that it is in part familiar already, one would expect retention to be assisted. Further, the widely ramifying associations which meaningful material has with the other retained acquisitions of the individual aid significantly in retention.

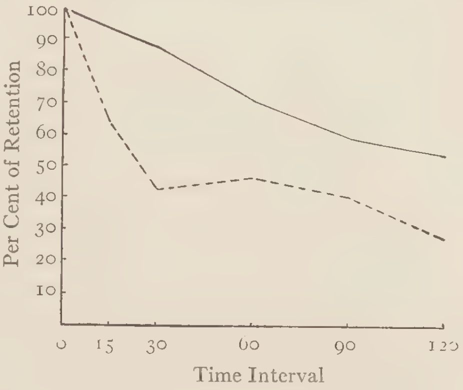

FIG. 93.—Retention curves for meaningful materials. Solid line represents narrative reproductions of observed material, broken line recall of poetry. (From McGeoch and Whitely, *J. Educ. Psychol.*, XVII [1926], 422; and Whitely and McGeoch, *J. Educ. Psychol.*, XIX [1928], 477.)

A comparison of the retention curves of Figs. 87 and 93 will show characteristic differences between the retention values of three different materials. The Ebbinghaus curve of Fig. 87 was obtained by the saving method with nonsense syllables, and the curves of Fig. 93 by written reproduction of poetry and of the contents of a card on which were pasted six objects. The differences in method are insufficient to account for the differences in results, however. The curve of forgetting for poetry has the general form of the classical curve, but it drops much less rapidly. After 120 days there is a retention of 28 per cent, an amount almost exactly equal to that for nonsense syllables after two days. The curve for observed material is almost linear and shows a retention of 55 per cent after 120 days. The divergence from the Ebbinghaus curve-form probably results from the fact that no recalls were taken for short intervals after learning. Clearly the character of the material is one significant factor affecting retention. The two meaningful materials are retained after 120 days as well as or better than nonsense syllables after only two days. We can, of course, never be sure that the degrees to which such widely different materials have been learned are comparable, but in the three cases compared it is a fair assumption that real differences resulting from the nature of the materials remain after those due to degree of learning have been cancelled out, especially since relatively brief learning times were allowed the two meaningful materials.

Length of List. It is a general result that longer materials are more slowly forgotten than are shorter materials. It will be recalled that the longer lists are proportionally the more difficult to master, and this greater relative difficulty presumably results in a correspondingly greater overlearning and hence in better retention. There are probably upper and lower limits to this principle, but it holds for the lengths of material ordinarily used in experimental work.

The Influence of Affective Tone. The problem whether the pleasantness and unpleasantness of the material has a significant influence upon retention has intrigued the fancy of many an investigator and numerous experiments have been performed to study it. Certain difficulties face all such experiments. Pleasant and unpleasant materials are apt to be known better to the subject prior to the experimental measurement of their recall than are indifferent materials, and one cannot, therefore, be wholly certain that he has isolated feeling tone from degree of prior learning. However, the drift of the results is in favor of the better recall of pleasant materials, with unpleasant and indifferent materials following in the order named. In recall of past experience, at least, the temperament of the subject is an important factor, as the studies from Professor Washburn's laboratory have clearly shown.

Memory versus Skill. It has often been contended that skilled acts such as typewriting and telegraphy are much better retained than are memory materials, and such statements often carry the implication that the difference is an inherent function of the differences between the materials and not of the experimental conditions. In many experiments a high degree of retention of skill has been found and when these results are compared with those from memory experiments, the former frequently has the advantage, especially when nonsense syllables are used as the memory materials. Poetry, observed data, and other meaningful materials are retained, however, almost if not quite as well as skilled acts, and there are a few cases on record in which memory materials are better retained than skills.

In a recent experiment the retention of three mazes of different degrees of difficulty has been compared with that of 8-, 12-, and 16-syllable lists after a period of seven days. Both mazes and syllables were learned to one perfect repetition during the learning period and after one week were relearned to three perfect repetitions. In terms of saving in trials, the syllables were consistently better retained than were the mazes. By the other criteria the mazes tended to excel the syllables. By every method of treating the data, however, at least one syllable list excelled one maze. The results indicate that, when the degree of learning is more nearly equal, neither one is consistently retained better than the other by all criteria. Which is better retained is a function of such factors as the criterion used, and the particular maze and list compared. In the older experiments from which the conclusion that skilled acts are the better retained was drawn, the amazingly high retention was explicable in terms of the correspondingly high degree of overlearning which was present.

THE CHARACTERISTICS OF THE SUBJECTS

Individual Differences, Sex, Age, and Intelligence. The same general range of individual differences appears in retention as in learning. Further, with individuals of the same age and under similar conditions of learning, he who learns fastest retains best, thus destroying the fond prejudices of some who wish to believe in a benign Emersonian compensation in the world of memory.

Retentive ability, as does memorizing ability, increases with increasing age up to maturity, excluding the special conditions under which reminiscence occurs. There is evidence that, of what they learn, children retain relatively more than adults, but in absolute terms they learn and retain much less. It seems that Thorndike's age curve holds roughly also for retention, although the latter has been worked out less thoroughly.

Again small and variable differences between the sexes appear. If anything, the girls excel the boys until early adolescence, when the boys take the lead. The differences involved are, however, slight and one can draw no conclusion of any generality save that inherent sex differences in memory capacity, if they exist, are very small. Likewise, the more intelligent retain larger absolute amounts of the material than the less intelligent. Whether they retain larger relative amounts is not as clearly established.

Other Factors. Under this head will be summarized the influence of several factors which may be treated very briefly. It will be recalled that a condition of muscular tension is favorable to learning. The tension condition is also beneficial to retention. It is difficult to isolate the influence of fatigue from that of increase in efficiency through practice at memorizing which, if present, will mask the fatigue. There is some indication, however, that material learned under a condition of relative fatigue is retained less well than that learned in a more rested condition. It has previously been stated that the intent to learn exercises a significant influence on learning. It also appears that learning with the determination to remember indefinitely or permanently is influential in securing a high degree of retention.

THE INFLUENCE OF CONDITIONS AND METHODS OF LEARNING

In many cases the influence of particular learning methods upon retention has been studied but incidentally. It is generally assumed that, other things being equal, the method which is best for learning is also best for retention. This may be true if the material is learned to an equal degree by each method. Actually, however, it often happens that the poorer learning method gives the better retention because under the conditions of the experiment overlearning was much greater by the poorer method. It is difficult, therefore, to make a valid generalization covering all learning methods. The results from a few of the most conclusive experiments on the influence of learning methods upon retention will be cited.

Distribution of Time. The general outcome of the experimental work on the retention values of distribution is that, even though distributed practice may be but slightly superior to massed practice in its influence upon retention over very short intervals, it is, for retention after a day or more, much the more effective.

In an experiment with paired associates it was sought to discover what form of distribution after an original partial learning would yield the best results. Three successive trials were given to all groups on the first day of learning, and six succeeding trials were distributed over an eleven-day period according to three hypothetical retention curves: negatively accelerated, positively accelerated and linear. The results strongly favor the mode of distribution with short rest intervals at first and with later intervals of increasing length. This distribution on the assumption of negative acceleration ranked first, with positive and linear assumptions following in the order named. It has also been shown that the duration of the learning period has more influence on retention than the duration of the rest interval, and that study periods whose lengths increase in geometric proportion are much better for retention than study periods of equal length.

Other Methods. The results from other methods may be summarized very briefly. The advantage of recitation during memorizing in the previously mentioned work of Gates was even more pronounced in retention after four hours. Apparently, also, an attempt to recall immediately at the close of the study period is highly beneficial to retention. We may well expect that other recalls during the interval would have to some degree a similar effect. There is some evidence, although it is not entirely conclusive, that the whole method tends to give better retention than does the part method. Experiments upon the type of retention involved in the making of a report (testimony) upon experienced events show that numerous factors, such as suggestive questions and reading about the event in the newspaper, operate to decrease the reliability of the report.

Degree of Learning. There is little doubt that the rate of forgetting is a function of the degree to which the material had been learned at the close of the learning period. This was first worked out by Ebbinghaus who repeated lists of nonsense syllables varying numbers of times and studied the influence of the number of repetitions on the saving score after twenty-four hours. When saving was plotted against repetitions the result was almost a straight line (Fig. 94). Ebbinghaus also computed that for each three repetitions of a list on any given day one repetition was saved in relearning after twenty-four hours. This experiment has been repeated using 2, 4, 6, 8, and 10 repetitions and it has been found that within these limits Ebbinghaus' conclusions hold.

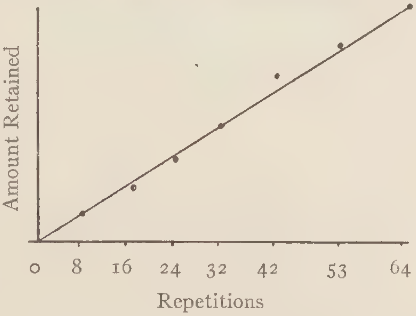

FIG. 94.—The decrease in retention with decreasing repetitions. (From Ebbinghaus, after Pillsbury, *Fundamentals of Psychology*, p. 370.)

The question how long this linear increase will continue at once arises. The exact point at which negative acceleration begins varies with several factors, but a general answer is contained in the work of Luh and Ebbinghaus. Luh's subjects learned 12-syllable lists to degrees of learning represented by the percentages 150, 100, 67, and

33. For most intervals up to two days the amount of retention varied with the degree of learning. The differences between the curves for 33 per cent and 67 per cent learning were greater than those between 67 per cent and 100 per cent, while those between 100 per cent and 150 per cent were least of all. Thus as degree of learning increases to the threshold and beyond, diminishing returns (negative acceleration) appear. Increase in degree of learning also favors the more difficult retention methods over longer periods of time. Luh employed the methods of written reproduction, reconstruction, and recognition. His experiment verifies the implications of Ebbinghaus' earlier work on the same problem with the saving method. There is little doubt that at some point in learning diminishing returns in later retention will set in, but one may well expect significant returns from a fair amount of learning effort beyond the point at which the material can barely be repeated.

EXERCISES

1. A list of words is more readily learned than a list of an equal number of nonsense syllables. It is sometimes said that this is because the learner is sure to have the words partly learned even before they are presented to him. Can this be true?
2. Give a short list of the books which you remember best. How do you account for the greater impression of some of your reading?
3. If adults learn about as readily as children, can you still see good reason for learning a foreign language during early youth?
4. If one had to study French, German, and mathematics, during successive hours, what would be a good order? Why?

5. OBSERVATION AND REPORT[1]

BY GUY MONTROSE WHIPPLE

Whenever any interval of time elapses between the actual carrying out of observation and the recording of it by word or gesture or pen, the accuracy and completeness of the record tends to be reduced by errors of memory. The original work of observation means, of course, that series of impressions that arise in the sense organs are carried to the brain where they leave some sort of trace, produce some sort of modification of the nervous substance. We know that this trace or modification is relatively unstable, that it tends to disappear, rather rapidly at first, then more slowly. You can recall now in considerable detail what you have been doing the last thirty minutes; tomorrow at this time you will be able to recall many fewer details; a year from now the doings of these last thirty minutes will have faded into oblivion unless some special occasion has led you to rehearse them and to keep the memories polished. Other things being equal, the longer the time has elapsed between your conversation and your recall of it, the less complete and the less trustworthy will be that recall.

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[1] Adapted from "The Obtaining of Information: Psychology of Observation and Report," *Psychological Bulletin*, XV (1918), 233–47; "Outlines of the Study of Human Action for the Students Army Training Corps," Section VI.

The most common inadequacies of memory are errors of omission. Read the following paragraph straight through two times then close the book and write as much of it as you can remember.[1] Use the words of the original when you can, but use your own words if you can't remember exactly those you read.

THE DUTCH HOMESTEAD

"It was one of those spacious farmhouses, with highridged, but lowly sloping roofs, built in the style handed down from the first Dutch settlers, the low projecting eaves forming a piazza along the front capable of being closed up in bad weather. Under this were hung flails, harness, various utensils of husbandry, and nets for fishing in the neighboring river. Benches were built along the side for summer use; and a great spinning wheel at one end, and a churn at the other, showed the various uses to which this important porch might be devoted. From this piazza one might enter the hall, which formed the center of the mansion and the usual place of residence. Here rows of resplendent pewter ranged on a long dresser dazzled his eyes. In one corner stood a huge bag of wool, ready to be spun; in another a quantity of linsey-woolsey, just from the loom; ears of Indian corn and strings of dried apples and peaches hung in gay festoons along the walls, mingled with the gaud of red peppers."

This paragraph contains in all 180 words and approximately 94 distinct ideas. It will be found that no one can recall all of these ideas and that surprisingly large differences appear within any group of men that try it. It will also be found that the difference between the reproduction and the original lies almost entirely in the omission of ideas. The impressions made by the reading have faded or "shrunk," one might say, by an amount that varies with the relative capacity of the individual.

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[1] If this test is tried as a group, let some one keep the time and allow two minutes for reading the passage through twice and studying it in any way that is wished in what time may remain. Details for carrying out the scoring exactly are given in the writer's *Manual of Mental and Physical Tests*, Part II, page 120.

The recall of what has been observed is liable to falsification by erroneous insertion. If several observers try the experiment with the *Dutch Homestead* selection, it will almost surely happen that some one will add to his description details that were not present in the original paragraph. This type of mistake will usually be even better illustrated in the tests of describing a picture or a person from memory. Most of the insertions thus made will be found to be of the plausible sort, that is, they might quite well have been present in the thing or event under observation, and most of them will be found to relate to minor details. They represent, therefore, a tendency to fill out memories in such fashion as to make them accord with ordinary experiences. The main ideas are retained fairly accurately, but minor details are erroneously added that are not inconsistent with the main ideas, though they were not actually observed. From this it will be understood that these false additions are peculiarly serious when the observer is trying to recall something out of the usual run of his experience, for not only will he not have observed the details correctly, but he will unwittingly make absolutely wrong and misleading additions to his memories of what he did not observe correctly. And what is worse, he will not be conscious of the erroneous additions. The best way to meet this source of error in getting and reporting information is evidently to caution the observer to be on his guard against the tendency and to quiz him to determine just what items in his account he positively did observe and what ones he merely inferred to be present.

The recall of what has been observed is liable to falsification by substitution. This source of error is similar to that just described, only by substitution we refer to cases in which, instead of a simple addition of extraneous material, some of the original items are dropped and other items are inserted in their place. Many of the common alterations that characterize our accounts given from memory are of the general nature of substitutions. Thus, I once had an argument with a young lady about the possibility of "table tipping." She told of a simple experiment that had occurred in her own parlor when, so she said, a half dozen persons were seated about a light table and succeeded in making one edge of it rise an inch in the air by all concentrating their wills upon it. I expressed polite incredulity and suggested that such a thing might occur easily enough by unconscious pressures and pulls in the hands of the sitters. "That," the young lady retorted, "was impossible because when we exerted our wills upon the table, our hands were lifted off it." "Then I must really declare," I replied, "that your memory of the affair is at fault. You admit that it was several years ago." Whereat she exclaimed: "Here is where I convince you that other people besides psychologists know how to conduct experiments. I wrote down an account of it that very evening and I remember that I wrote about the hands being lifted in the air." She ran upstairs for her diary and finally produced her notes on table tipping, only to read in some dismay: "When the signal for exerting our will was given, we all laid our hands upon the table with little fingers crossing with our neighbor's so as to make a complete circle for the 'magnetism.' Pretty soon one edge of the table lifted several inches into the air!" Here the item "hands-on-the-table" was quite forgotten and there had become substituted for it the item "hands-lifted-in-the-air."

The recall of what has been observed is liable to falsification by transpositions in the time, order and space arrangement of items. Illustrations of these errors can be obtained by any persons by reference to his own difficulties in giving a correct account of any series of events that occurred in rapid sequence. An excellent illustration is afforded in the accounts given in the court room by eye witnesses of an accident or of a street brawl. Absolutely contradictory answers are given by perfectly honest witnesses to such queries as: "Did the engineer apply the brakes before he whistled?" "Who struck the first blow?" "Was the accused standing in front of, or behind his brother?" "Which man went ahead and cut the wire?" "Did the explosion follow or precede the rocket signal?"

Here, again, as in other errors of memory, there is a strong tendency unwittingly to rearrange the order of events to accord with what would be the order under most circumstances. Hence the memory of a series of events that really occurred in a time order or in a spatial arrangement contrary to the usual order or arrangement is peculiarly liable to error.

The omissions, insertions, substitutions and transpositions that affect the accuracy of recall are often quite unnoted by the observer. It may appear that this principle is self-evident, that if these errors were noted, they would not be made. In a way this is true, but it must be remembered that the recall of an event may take place with all degrees of confidence in its accuracy—from what is only a shade better than a guess to the most complete positiveness. Thus, a gap in the recall of a series of events might be without serious consequence provided its existence were known and mentioned—if, for instance, the report is made: "I have forgotten just what reply was made to the officer's question"—whereas the same gap might be of serious consequence if it were closed in memory—if, for instance, the report is made: "No reply was made to the officer's question." Similarly, with the other sources of error. The general principle involved is plain enough. What is wanted in a first-class observer is not necessarily a wonderfully detailed memory: rather a cautious memory, a recall in which the possibility of a slip of memory is always kept in mind and in which positive assurance of accuracy is made only with respect to those portions of the report that warrant this assurance.

These facts may be demonstrated by trying again any one of the tests of memory previously described (such as the paragraph read) and asking each participant in the test to glance over his written account and underline every statement to the accuracy of which he would swear were he testifying under oath in court. It will be unusual if more than half of the participants do not underline at least one statement that is factually wrong. The moral is obvious enough: If under these very favorable conditions—with complete understanding of what was to be done, with a warning as to when the object was to be observed, with no undue fatigue or emotional excitement, with no one to badger or hector by cross-questioning aimed to confuse, with a very short interval between observation and the recording of it—if, under these circumstances, almost every man is liable to swear positively that he recalls something that can be demonstrated to be wrong, then how inaccurate must be the memory of most men under the unfavorable conditions of observing and recalling events that we encounter in daily life, to say nothing of events that are encountered in military reconnaisance observation and patrol work!

The correct recall of one feature of an object or event does not guarantee the correct recall of other features of the same object or event, even though these features seem logically bound up in one another. On one of the test-cards often used in laboratory experiments some half dozen different objects are pasted. Among these is a rectangular red label, having a narrow white border and the words "Handle with Care," printed in white letters. It happens often that observers recall that the label was red, but forget its shape; or that they recall that it said "Handle with Care," but report that these words were in black type

Errors of this sort seem almost illogical; that is, it seems as if a correct recall of the words must inevitably be associated with a correct memory of the color of type in which they were printed. But psychologically, it is clear how this last sort of error can occur: the observer may really bring to mind not the original visual picture of the label but his memory of the words as words.

Many people who are ignorant of these facts are too ready to accept the account given by an observer as accurate in its entirety because it is known to be accurate in all those details that are subject to verification. It is true, of course, that if an account states correctly, let us say, 23 points with regard to a certain matter and there are stated two more points not open to verification, there is high probability that these two are also correct, but it is equally true that they *may* not be correct.

When a number of persons report upon the same matter, those details upon which agreement appears may in general be considered as correct. This principle may be demonstrated by reference to almost any of the experiments that have been suggested in the pages that precede. Go over, for instance, the reports made upon the contents of the paragraph, upon the picture or upon the appearance of the persons walking past. Note the statements made by all the observers, by 90 per cent. of them, by 50 per cent. of them, by 10 per cent. of them and by only one observer; see which ones of these statements are correct.

But if a number of persons agree perfectly in their statements about numerous small details under circumstances such that observation must have been difficult and memory of them must have been likely to unintentional error, then suspicion is justified and collusion is probable. Lawyers and court magistrates are well aware of this principle. When several witnesses tell precisely the same story of the scenes attendant on a riot or assault or murder, for example, everyone conversant with human nature knows that this sort of agreement is contrary to expectation. It is almost a certain sign that these witnesses have talked over the matter beforehand and have agreed upon the story they have told, or it indicates that the later witnesses have been influenced by the earlier ones and are unable to separate their own memories of the original experience from their memories of what they have heard others tell about it. A corollary easily drawn from this principle is found in the following principle.

When the truth is to be ascertained by the examination of several witnesses of the same event, these witnesses should be examined separately and if possible before they have been able to exchange ideas about it.

When information obtained by one person is communicated by him to another person a certain amount of inadequacy is almost invariably introduced by the very processes of communication. Hand to several persons, separately, some familiar object, for instance, a jackknife, a blackboard eraser, a kodak print, a bunch of keys. Ask each one to describe the object so carefully that any one who heard this description would have as good an idea of the object as if he himself had seen it. Let each of the descriptions be listened to at the time or read afterward by another person; ask this last person to make up his mind very carefully just how the object will look, then show it to him and ask him if it differs in the slightest degree from his expectation of it. Was the inadequacy or the mistake due to the verbal description or to the hearer's interpretation of the description? Could it have been avoided? This test can be extended to objects or events of any degree of complexity. Thus, let a group of persons look out of the same window and let one of them describe out loud what he sees, hears, feels or smells, with the idea that he is to make his description as clear and as complete as he can. After, say, a minute of this, stop him and ask others in the group how they would have given the description, *i.e.*, in what respects they would have differed from the account they heard.

Simple experiments of this sort will bring out the following points. In these situations there is practically no reason for discrepancies due to faulty sense organs or distraction of attention or failure to understand what is being observed, nor is there any opportunity for omissions, additions, substitutions or transpositions attributable to faults of memory. Whatever discrepancies do appear are due to the difficulty of "translating" the objects and events that are correctly enough perceived into suitable words—"suitable" in the sense that they succeed in arousing in the mind of a listener a reasonably complete picture of what is being described. The fault will usually be found to lie in both parties, in the person who is observing and making the statements and in the person who is listening and trying to comprehend these statements.

The same result obtains if the observer tries to use gesture or pantomime or drawings, instead of words or in addition to words to convey his meaning.

It hardly needs to be added that when this task of communicating information concerns objects or events not under observation at the moment, but merely being recalled from memory, the chances for inaccuracy and incompleteness in the process of "reporting" (as the psychologist terms this process of translating into words) are decidedly increased.

The most prominent inadequacy in description is incompleteness or simplification. The description of an object is almost invariably simplified, that is, a considerable number of its features, often fairly important features, are not mentioned. It is to be noted that this is quite apart from the tendency to omission due to the fading of impressions in memory, for in such simple tests of ability to report as have just been suggested there is no call for the use of memory at all, but only for description. In one test of this sort conducted by the writer, a photograph was exhibited to a group of observers. Counting all the reports, 22 different objects or features were mentioned, yet the average number mentioned by a single person was only 9.4. Similarly, the French psychologist, Binet, had 150 persons describe a simple photograph and found no two of these descriptions were alike. In another test he asked 36 persons to describe a picture. Of these persons, everyone mentioned the old man who formed the center of the group in the scene, but only 29 mentioned the fact that he was lying on a bed; only 27 mentioned a woman seated near him, while only 4 mentioned that one of the children held a stick in his hand. Here we have an illustration of the fact that the more prominent the feature, the more likely it is to be mentioned in any description. That is, the simplification that characterizes all report does not occur in a haphazard manner, but in accordance with a general tendency to put the greatest emphasis on what the observer feels to be most important and to pass by without mention what he feels to be unimportant. It will be evident, doubtless, how greatly training can improve observation and report in this respect. If the observer understands clearly that things that he once thought to be trivial and meaningless have a high degree of significance, he no longer passes these by without mention.

The attempt to label an observer as belonging to a certain "type" on the basis of what he does in a preliminary trial is of doubtful utility. It is more important to determine his susceptibility to improvement by training. Students of human nature have sometimes attempted to classify men with respect to their tendencies to report what they have observed in this or that characteristic way. Thus, descriptions have been sorted as displaying predominantly imagination, moralizing, emotional reaction, erudition, simple enumeration, etc. Note, for instance, these two descriptions of a cigarette:

"The cigarette before me has the general form of a cylinder cut at one end by an inclined plane where the paper is folded. The paper, which is striped lengthwise, is somewhat bruised. The tobacco projects about 0.5 cm. from one end," etc.

"We have before us here a cigarette. Let us see how it is made. In the first place the exterior envelope is of light paper, called silk-paper. Then, inside is the tobacco. Tobacco is a product that grows almost everywhere in warm or temperate climates. The leaves of this shrub are gathered, and, after a treatment that lasts four years, are turned over to the public in the form of powder, that is, snuff, or in shreds, as in the present instance," etc.

The first description is listed as the work of a "describer" or "enumerator" because it merely catalogs the features of the object with little attempt at explanation or interpretation. The second description illustrates the work of the "erudite" individual, who tells what he knows or has been taught, rather than what he observes. However, it remains to be determined whether the person who wrote the second description might not write an equally straightforward enumerative sort of description, like that of the first person, if he understood that that was the kind that was wanted,—at least after one or two trials under training and correction.

It will be seen from this comment that one cannot determine by any sort of offhand test what ability a man might demonstrate in a given line of military observation. It was reported early in the war, for instance, that a certain officer engaged men in conversation while he walked down the aisle of a department store with them and then recommended their rejection as aeroplane observers if, without previous warning that they were under test, they could not give a clear account of the goods displayed on the counters of the store. This story may have no foundation, but if true, it is an excellent example of how dangerous lack of elementary psychological knowledge may be. Failure to pass such a test would indicate nothing of lack of capacity to be trained for military observation. In fact, if it showed anything, a poor score in such a test would simply show that the listener gave such close attention to the officer's remarks as to be oblivious to the mercantile appeal of the bargain counters. Presumably such a man would make good material for training.

We are reminded in this connection of the pompous English school inspector mentioned by Adams, I think, in his *Herbartian Psychology Applied to Education*, who asked a class of pupils: "Children, at which end does a recumbent cow begin to arise?" and who, when no response was forthcoming, proceeded to reprimand the trembling teacher for not having taught her charges the fundamental need for comprehensive and accurate observation. What she ought to have said to squelch the inspector was: "Who cares how the recumbent bovine begins to arise, and how does failure to have remarked her *modus operandi* in assuming an erect posture demonstrate that my children cannot observe properly on occasion?"

From what has just been said it must not be supposed that individuals do not display conspicuous and more or less persistent differences in their types of description. They do show these differences, only the differences may be to some extent reduced by special training and are not in any event to be assumed present on the basis of a single trial under artificial and not clearly understood conditions.

If by an error is meant any distinct discrepancy between items reported and the actual facts, it may be laid down as a rule that, even in the case of competent adults, observing and reporting under favorable conditions, an errorless report is the exception. On the contrary, if the report attempts to get down to details, the average reporter will make a score of about 75 per cent. in accuracy, not counting omissions as errors. This statement is based upon repeated trials under experimental control in the psychological laboratory. In such trials the conditions are uncommonly favorable—the observer knows what he is to observe, when it will appear, how long it will be perceptible, and understands that he is to make a report almost immediately afterward. Observers who must do their work under markedly less favorable conditions certainly cannot be expected to make much better scores.

The few exceptional reports that are errorless are usually found to have only a very small range. That is to say, it is possible to make a score of 100 per cent. in accuracy by refusing to make any statement that is not felt to be positively correct. Indeed, in some instances of this sort that have come to my notice, the report was so much restricted in order not to make an error that it was almost valueless as a conveyor of information.

The practical significance of this principle is that every piece of testimony must be accepted with caution. If you are an officer and if your men make to you a series of reports that run at all into detail, you may be sure that the chances are better than one to one that there is at least one mistake in each man's report.

If the various items that constitute a report are sorted by the reporter into groups according to the degree of certainty he feels as to their accuracy, then the items in the group characterized by the highest degree of *certainty will be found to be distinctly more accurate than those placed in other groups, but a first-class, highly trained observer will at times be absolutely wrong with respect to statements to which he attaches the highest degree of certainty.* In illustrating the principle that slips of memory are often unnoticed it was suggested that the report of the paragraph read or of the picture or persons seen be marked to show what items would be sworn to as correct, with the reporter giving testimony in court under oath. It is to statements like those underlined in that experiment that we refer to as "items in the group characterized by the highest degree of certainty." In laboratory experiments, when all statements are divided into two groups—those "sworn to" and those not—the items in the former group usually contain about 10 per cent. inaccuracy as over against some 20 to 25 per cent. inaccuracy in the latter group. It is possible to distinguish more than two degrees of certainty; it is not difficult, for example, to grade each item in your report on a scale of five points: (1) absolutely postive, (2) very certain, (3) fairly certain, (4) doubtful, (5) little better than a guess. If this is done by the members of a class and if the number of errors are counted for items reported with each of these five degrees of certainty, it will be found that the proportion of errors tends to increase as the degree of certainty decreases.

The practical application of this principle is not far to seek. Men who are being trained for work in intelligence sections ought to understand thoroughly that error tends to be inversely proportional to certainty, and they ought to be encouraged to qualify their reports by indicating the degree of certainty attaching to important items. Thus, their reports should contain such phrases as: "I am positive that" so and so; "I am fairly sure that" so and so; "I am inclined to think" so and so; "I overheard only snatches of conversation and can only hazard a guess that" so and so.

EXERCISE

1. Test the validity of the foregoing generalization by means of experiment with "The Dutch Homestead."

6. THE "SECRET OF A GOOD MEMORY"[1]

BY WILLIAM JAMES

We have not so much a faculty of memory as many faculties of memory. We have as many as we have systems of objects habitually thought of in connection with each other. A given object is held in the memory by the associates it has acquired within its own system exclusively. Learning the facts of another system will in no wise help it to stay in the mind, for the simple reason that it has no "cues" within that other system.

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[1] Taken from *Talks to Teachers on Psychology: and to Students on Some of Life's Ideals*, pp. 124–29. New York: Henry Holt & Co., 1906.

We see examples of this on every hand. Most men have a good memory for facts connected with their own pursuits. A college athlete who remains a dunce at his books may amaze you by his knowledge of the "records" at various feats and games, and prove himself a walking dictionary of sporting statistics. The reason is that he is constantly going over these things in his mind, and comparing and making series of them. They form for him, not so many odd facts, but a concept-system, so they stick. So the merchant remembers prices, the politician other politicians' speeches and votes, with a copiousness which astonishes outsiders, but which the amount of thinking they bestow on these subjects easily explains.

The great memory for facts which a Darwin or a Spencer reveals in his books is not incompatible with the possession on their part of a mind with only a middling degree of physiological retentiveness. Let a man early in life set himself the task of verifying such a theory as that of evolution, and facts will soon cluster and cling to him like grapes to their stem. Their relations to the theory will hold them fast; and, the more of these the mind is able to discern, the greater the erudition will become. Meanwhile the theorist may have little, if any, desultory memory. Unutilizable facts may be unnoted by him, and forgotten as soon as heard. An ignorance almost as encyclopedic as his erudition may coexist with the latter, and hide, as it were, within the interstices of its web. Those of you who have had much to do with scholars and *savants* will readily think of examples of the class of mind I mean.

The best possible sort of system into which to weave an object, mentally, is a *rational* system, or what is called a "science." Place the thing in its pigeon-hole in a classificatory series; explain it logically by its causes, and deduce from it its necessary effects; find out of what natural law it is an instance,—and you then know it in the best of all possible ways. A "science" is thus the greatest of labor-saving contrivances. It relieves the memory of an immense number of details, replacing, as it does, merely contiguous associations by the logical ones of identity, similarity, or analogy. If you know a "law," you may discharge your memory of masses of particular instances, for the law will reproduce them for you whenever you require them. The law of refraction, for example: If you know that, you can with a pencil and a bit of paper immediately discern how a convex lens, a concave lens, or a prism, must severally alter the appearance of an object. But, if you don't know the general law, you must charge your memory separately with each of the three kinds of effect.

A "philosophic" system, in which all things found their rational explanation and were connected together as causes and effects, would be the perfect mnemonic system, in which the greatest economy of means would bring about the greatest richness of results. So that, if we have poor desultory memories, we can save ourselves by cultivating the philosophic turn of mind.

There are many artificial systems of mnemonics, some public, some sold as secrets. They are all so many devices for training us into certain methodical and stereotyped *ways of thinking* about the facts we seek to retain. Even were I competent, I could not here go into these systems in any detail. But a single example, from a popular system, will show what I mean. I take the number-alphabet, the great mnemonic device for recollecting numbers and dates. In this system each digit is represented by a consonant, thus: 1 is *t* or *d;* 2, *n;* 3, *m;* 4, *r;* 5, *l;* 6, *sh*, *j*, *ch*, or *g;* 7, *c*, *k*, *g*, or *qu;* 8, *f* or *v;* 9, *b* or *p;* 0, *s*, *c*, or *z*. Suppose, now, you wish to remember the velocity of sound, 1,142 feet a second: *t*, *t*, *r*, *n* are the letters you must use. They make the consonants of *tight run*, and it would be a "tight run" for you to keep up such a speed. So 1649, the date of the execution of Charles I., may be remembered by the word *sharp*, which recalls the headsman's axe.

Apart from the extreme difficulty of finding words that are appropriate in this exercise, it is clearly an excessively poor, trivial, and silly way of "thinking" about dates; and the way of the historian is much better. He has a lot of landmark-dates already in his mind. He knows the historic concatenation of events, and can usually place an event at its right date in the chronology-table, by thinking of it in a rational way, referring it to its antecedents, tracing its concomitants and consequences, and thus ciphering out its date by connecting it with theirs. The artificial memory-systems, recommending, as they do, such irrational methods of thinking, are only to be recommended for the first landmarks in a system, or for such purely detached facts as enjoy no rational connection with the rest of our ideas. Thus the student of physics may remember the order of the spectral colours by the word *vibgyor* which their initial letters make. The student of anatomy may remember the position of the Mitral valve on the left side of the heart by thinking that L. M. stands also for "long meter" in the hymn-books.

EXERCISE

1. What are the advantages and disadvantages of having one's facts woven into a science?

7. THE TRAINING OF MEMORY

A. The Effects of Training[1]

BY WALTER B. PILLSBURY

On rote memory there has been a large amount of work done in the last two decades, work that for the most part has not been directed to our particular problem of training the memory. In the experiments, great care is taken to control all possible sources of error. The material employed is usually lists of nonsense syllables that have never been used and so probably have never been learned even in part before. Then again, the syllables are exposed at perfectly regular intervals by an instrument that permits but one to be seen at a time and insures that each shall be shown for the same length of time as any other. A vast number of other apparently insignificant details, that experience has shown to be important in their effect upon learning, are carefully lookt to that no single extraneous factor may come in to obscure the results. It has been noted in nearly all experiments that have extended over a considerable time that the amount of effort required for learning became less with practice. Whatever the measure used, it has been found that fewer repetitions or less time is needed to perfect the learning process after practice than before. It was explained ordinarily that this was due to acquiring familiarity with unusual conditions of learning and with the new material, or at least that the practice would hold only for material of practically the same kind. In 1905, Ebert and Meumann published from the laboratory of the University of Zurich the results of a long investigation that had for its chief end the determination of the effects of training in learning material of one kind upon the capacity to learn material of the same and different kinds. The investigation was extended over a long period of time, and the effects of the practice were tested upon a sufficient variety of material to leave but slight room for doubt that the main outlines of the investigation will stand the test of time. Eight subjects took part. Their memories were first tested for ease of learning different sorts of material, such as series of letters, numbers, nonsense syllables, words, Italian words, strophes of poetry, and selections of prose. They were tested for retentiveness on some of the same kind of material, and in addition on visual signs that had no conventional meaning. After these tests had been made, the subjects turned to an investigation of a problem in the economical methods of learning that does not concern us here. In this investigation they learned thirty-two series of nonsense syllables; ordinarily they learned two series of syllables on one day and tested the retention of two more. In most cases this meant learning four series of twelve syllables each on each of sixteen days. At the end of this time the first test material was relearned and the facility of learning was compared with the original. After the second cross section thru the memory capacity, there was still another period of training. Four of the subjects were trained on sixteen series of the same material as before, and four who could give more time were subjected to the complete set of thirty-two series. When these had been finished, a final test of capacity was made that could be compared with the original condition and with the result obtained after the first period of practice.

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[1] Adapted from "The Effects of Training on Memory," *Educational Review*, XXXVI (1908), 18–24. Doubleday Page & Co., Publishers.

TABLE XIV

	3d Cross Section	2d Cross Section	1st Cross Section	Per Cent Gain 3 over 2	Per Cent Gain 3 over 1
Numbers	11.2	8.8	7	26	59
Letters	11.3	9.5	7.2	19.3	58.2
Nonsense syllables	7.3	6.2	5.2	19	42
Words	8.8	7.3	....	20.5	....
Italian words	6.5	5.5	5	18	30
Poetic words	19	17	15	12	27
Prose words	22	19	17	16	29

The results fell out entirely in favor of special training giving a general effect. For every subject there was a progressive increase thruout the series both in quickness of original learning and in the amount of retention. Not only this, but the effect of training from learning nonsense syllables extended to the other materials that were used, and in nearly the same degree as the closeness of the relation between the kinds of material. The table will show the results in general outline. It gives the average for the subjects on the eleven different forms of work. We may divide the results into two groups: one shows the effect of training on original learning; the other, the effect of the training on retention, on the retentiveness of the memory as measured by the number of repetitions required for relearning after the lapse of twenty-four hours.

In this table (Table XIV) the figures all indicate the number of units that could be retained on one repetition.

It can be seen from the tables that in every case there was a gain in the average performance of the eight observers for each kind of material used. It will also be seen that there is a tendency for the gain to be greatest in material that is most closely related to that on which practice was obtained. The difference is not, however, sufficiently great to make it at all probable that rote memory for any sort of material would not be increased as a result of practice in learning anything else. It is also a striking result that the retentiveness of the memory should be increased as well as its quickness. It is suggestive of the extent to which training may go that the second period of training should still show a very marked effect. Indeed it was the original intention of the investigators to continue practice until a limit was reached, but this did not seem practicable. The limit conjectured by the authors was a degree of training that would permit complete learning of the series used at a single repetition. There was some difference in the amount of training between different individuals. This could be traced in large part to the amount of earlier training.

TABLE XV*

Average Number Seconds per Syllable

	3d Cross Section	2d Cross Section	1st Cross Section	Per Cent Gain 3 over 2	Per Cent Gain 3 over 1	
Learning.....	0.48	0.83	2.11	43	77	Nonsense syllables
Relearning...	0.20	0.27	0.49	35	59	
Learning.....	0.90	2.23	3.83	59.6	75.5	Optical symbols
Relearning...	0.30	0.35	0.68	14.3	55.9	
Learning.....	.108	.175	.273	32.8	60	Italian words
Relearning...	.036	.040	.056	10	36	
Learning.....	0.47	0.6	.75	21.6	37.3	Line of poetry
Relearning...	.07	.08	0.14	12.5	50	
	Readings Required					
Learning.....	50	99	175	49	71.4	20 lines of prose
Relearning...	9	12	36	25	75	

* In this table the figures indicate the average time in seconds required to learn each syllable except in the last instance, where the results are given in number of readings.

The smallest amount of training was shown by Professor Meumann, who has devoted a large proportion of his time in recent years to learning nonsense syllables and in conducting investigations in memory. Still he did not fail to show some evidence of training in most of the tests that were made.

Surprising, too, are the results of tests of the persistence of the effects of training. Tests made after the lapse of from seventy-five to one hundred and fifty-six days of vacation showed that there had been no loss of the training; in fact, in several instances there had been an actual increase in memory capacity. If we are to take these results at anything like their face value, it would seem that memory is capable of being trained to an indefinite degree, and that training in one field carries with it training in other related fields, but they need not be so closely related as to render it at all likely that training in remembering any one sort of material would be entirely without effect in any other field. This effect of training is not transient apparently, but persists, or its effect may even be increased after the lapse of considerable time.

It might be objected that training of this kind is impracticable and that the methods of training, the materials used, and the methods of testing are so different in character from those that would be used in practice that it is possible to draw no conclusions from them to apply to the fields where we are really interested in producing results. This may in part be met by citing the results of some experiments of Winch on school children in Great Britain. The tests were made by learning selections from an historical reader, the training consisted in committing poetry or selections from a geographical reader. More than one hundred children, from three neighborhoods of different social standing, were chosen to be subjected to the tests. Each class was divided into two groups of approximately equal mental attainments. One group, after a test had been made, spent four periods in committing to memory about one hundred words of poetry, while the others were engaged in doing sums. The other classwork was the same for the two groups. On the fifth morning after, each group committed a second test passage. It was found that the children who had had the special practice averaged nearly ten per cent. better than those without training. And when the two first divisions were again grouped with reference to comparative merit, every group with training did better than the corresponding group without; a very striking result, considering the small amount of training. While these experiments are very much less complete and less carefully controlled than those of Ebert and Meumann mentioned above, they have the advantage of confirming the others on children of school age, on a larger number of individuals, and on material that is used in actual school practice.

The two investigations, taken together seem to leave little doubt that rote memory can be improved by practice. Our original theoretical question must then be faced: are we to interpret the results as a proof of the existence of a faculty of memory that acts in all the forms of learning that have been considered, or can we retain something of the more modern theory that the memory functions are in some measure distinct? It must be asserted that the former alternative of a memory faculty is not sufficiently in harmony with known physiological and pathological facts to be accepted, except as a last resort. The one alternative is to assume that, while there are different memories, they either overlap in part, and in sufficient measure to account for our results, or that there are other common elements of sufficient importance to account for the effect. The observations of the subjects in the experiments of Ebert and Meumann tend to favor the latter interpretation. Their progress seemed to be marked by greater capacity for attending to the nonsense material or to attending mechanically in general. Then, too, they acquired better methods of learning. Instead of attempting to help themselves by extrinsic devices, they became willing to give themselves over to the purely mechanical repetition of the material without much thought of the consequences. Each tends to adopt the method of learning that is most economical for himself. This varies from individual to individual, but it could be observed in each that the method of learning changed qualitatively as the exercises progressed. The persons tested took a devious course towards the end in the early experiments and gradually eliminated the bypaths that proved less profitable as time went on. It would seem, then, that a large part of the training, as it appears in the memory process, can be explained in terms of the acquirement of better methods of working and of a familiarity with the material and processes that makes relatively interesting what at first is probably as uninteresting a task as can easily be imagined. Ebert and Meumann were of the opinion that in addition there was a training of some common capacity that might be made to correspond fairly closely to memory as used in the popular sense. This does not seem to me to be a necessary conclusion, for no one knows how the gain due to these secondary factors stands to the total amount of improvement. One can not be sure, therefore, that all of the gain is or is not to be explained in terms of the change in these capacities that are generally assumed to be susceptible of training.

What explanation is to be offered for the fact is of less importance than is the fact itself. It seems pretty certain, if we are to place any confidence at all in these results, that memory as a rough whole can be trained by comparatively simple methods to a degree that is great enough to offer practical advantages. It also seems that the fact of training can be explained in a way that will not be out of harmony with generally accepted principles of pathology, physiology, and psychology. It matters little, then, whether we still assert or deny that the training is or is not of memory, or is or is not of other functions related to memory. What we in every-day life call rote memory does improve with use.

B. Forms of Remembering[1]

BY CHARLES H. JUDD

We have of late come to regard memory work in the schools as something unworthy of recognition in comparison with reasoning and the higher thought-processes. No one who gives the matter any serious thought can, however, fail to recognize the fact that the criticism of memory is not based on any real expectation on the part of teachers that students will be able to carry on the higher processes without an appeal to memory. Criticisms of memory are directed not against memory, but against bad forms of remembering. Again and again the members of the class were required to go back into their memories and select the theorems necessary for progress in the demonstration in hand. Sometimes they offered an irrelevant theorem. This showed lack of discrimination in selection, or it showed poverty in the stock of ideas from which the selection could be made. When we speak of working out a demonstration, it is evident that the material stored in memory must be in form to permit selection and rapid review for the purpose of facilitating selective thought. One general principle of memory which immediately suggests itself in terms of the instructor's questions is the principle of arrangement. What do you know about equilateral triangles? What do you know about lines that are perpendicular to parallel lines? These are examples of questions which were asked with a view to helping students to classify knowledge. Furthermore, the classification must evidently not be too rigid, else the proposition which is needed now to illuminate the discussion from the point of view of the size of angles will not be available later when the same fundamental fact is needed in connection with the discussion of areas. Memory must therefore contain items classified in a variety of ways. When the student goes back into his store of experiences, he must find there many propositions ready for use in many different connections. To such a flexible memory there can be no objection. To a well-ordered body of knowledge, especially if it is well-ordered in many different directions, there can be no objection. From these statements of what is demanded of memory we begin to see how memory should be trained. If one wishes to have his students flexible and ready in ideas, then he must give them that type of memory training which will make them both ready and flexible. The problem of modern teaching is not to discard memory, but rather to train the powers of retention and recall in a better way than formerly. To object to memory is very short-sighted; to improve memory is rational.

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[1] Taken from *Psychology of High School Subjects*, pp. 70–72. Chicago: Ginn & Co., 1915.

We shall come back to this problem later. It is enough to point out here that ideas must be put into the mind with their possible relationships clearly recognized if these relationships are at some later day to be used productively in calling out the ideas. It is therefore important, when an idea is given, so to store it up in the mind that it shall be flexible and ready. One is tempted even at this stage of the discussion to point out that much of what has been said about the doctrine of formal discipline has been utterly at sea because it has not been based on this conception of the way in which ideas ought to be given. If ordinary school training does not transfer from one field of experience to another, this is not due to the inability of the human mind to transfer its training. The lack of transfer is in many cases due to the clumsy, stereotyped way in which ideas were put into the mind. The absence of general ideas and general habits of thought resulting from school work is due to poor teaching rather than to any limitations of the mind. Knowledge that does not transfer is inflexible and inert. It is badly remembered and was badly acquired. It shows that the mind is capable of taking in highly specialized ideas; it does not show that the mind is incapable of generalized experience, for generalization is seen to be dependent on the arrangement or organization of experiences.

EXERCISE

1. What are some wasteful methods of study that one would be likely to eliminate by practice?

CHAPTER XIV

IMAGINATION AND DREAMS

1. PRODUCTIVE IMAGINATION[1]

BY JAMES SULLY

Reproductive and Productive Imagination.—Reproduction involves the picturing of objects and events in what are called representative images, and is thus a form of imagination. In these reproductive processes, however, the images are supposed to be mere copies of past impressions. In other words, in reproductive imagination we retrace the actual forms and order of our presentative or sense-experience. But what is commonly known as imagination implies more than this. When we imagine an unrealised event of the future, or a place which is described to us, we are going beyond our actual experience. The images of memory are being in some way modified, transformed, and recombined. Hence this process is marked off as Productive or as Constructive Imagination.[2] And the results of the process may be spoken of as elaborated images, in contradistinction to the unelaborated images of memory.

While, however, we thus mark off (productive) imagination as a stage of psychological elaboration going beyond reproduction, it is easily seen that no hard and fast line of separation can be drawn between the two. The reproductive process in its complete form, the dating a past experience, involves a somewhat elaborate mode of construction in the time-scheme employed. Not only so, it is to be noted that what we call remembering or recollecting is by no means an exact transcription of the actual facts of presentation. The record of memory is being continually falsified by the effects of time, the loss of certain constituents of the experience, and the confusion of experiences one with another. And to this may be added that, in recalling past experiences, we tend, without any clear intention, to omit and even to rearrange so as to suit new circumstances, or gratify a new interest. Thus, in various ways, the reproductive process is adulterated by an admixture of subconscious production. It follows that what is here marked off as productive imagination consists of those processes where the modification or transformation becomes distinct and prominent, as in picturing others' experiences, or an experience that we regard as possible for ourselves.

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[1] Adapted from *The Human Mind*, I, 362–71. New York: D. Appleton & Co., 1892.

[2] Since this higher formative process answers to the common meaning of the term Imagination, we may for convenience sake omit the qualifying word productive, and speak of it as imagination simply.

Nature of Production.—It is evident that imagination as thus understood stands in a close relation to the processes of presentation and reproductive imagination. That imagination has to do in a special way with the things of sense was recognised by ancient philosophy. Whenever we picture a place, a scene, an event we read or hear of, we are engaged with sensible experience, the impressions of sight, hearing, and so forth. Such picturing is obviously effected by means of a reproduction of past sensations. To imagine "darkest Africa," and even the Heaven of Milton or Goethe, is to make use of our past sense-experiences. In other words, the impressions of sense when retained and reproduced supply us with the materials for our imaginative processes. Hence one obvious limit to all imaginative activity: it may produce new modes of combination, but no new elements.[1] .

Not only so, the modes of connexion of our experience necessarily reflect themselves in all our imaginative picturings. Thus it is obvious that all production makes use of those forms of combination which seem inseparable from our experience, *viz.*, the order of space and of time. Whenever we imagine, even in the wildest dreams of sleep, though we may be confusing particular positions or dates, we are still grouping objects in space and ordering events in time. Other illustrations of this reflexion of the connexions of our actual sense-experience are seen in our habitual picturing of things as concrete wholes resembling those we know through our senses, of the movements of objects as continuous from one point of space to another, and so forth.

It follows that what we mean by productive imagination consists merely in carrying our certain changes or modifications in that reflexion of our sense-experience which is supplied by the reproductive process. Such changes must in general consist of two kinds: (1) processes of separation and subtraction, and (2) processes of combination and addition. The former is illustrated in all picturing of objects away from their habitual surroundings, *e.g.*, a house on a new site; of isolated parts, features, or qualities of an object, as the head of a decapitated man, the colour of the orange or the gentian apart from its form; and of objects robbed of certain of their features or diminished in their size, as the one-eyed Cyclops, the diminutive Puck, and so forth. The latter process is seen in the imagination of objects with new features or in new circumstances, as in the stock instance, the mountain of gold, the centaur, the mermaid, the coral diver, and so forth.

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[1] In addition to such sensuous imagination, there is the imagination of inner mental states, and more particular feelings, a process that plays a large part in sympathy. But this direction of imagination may be disregarded for the present.

The processes of imaginative production now to be considered are carried out in relation to all kinds of sense-presentation. Thus, in the domain of hearing, musical tones and articulate sounds are susceptible of endless separation and recombination. So in the region of muscular experience or motor presentation, we may occupy ourselves with taking apart customary complexes, and forming new combinations, as in picturing the motion of flying, and so forth. Since, however, visual presentations constitute the most important class, presenting, moreover, the double complexity of a local juxtaposition of parts, and a combination of the heterogeneous and easily separable elements of colour and form, the imaginative process as commonly understood is specially concerned with unmaking and remaking visual or pictorial representations.[1]

Such imaginative manipulation of the material of sense-experience plays a large part in mental development. It is very far from being, as sometimes supposed, a mere pastime of the mind, but enters, as we shall presently see, as an integral factor into the development of intelligence.

Limits to Imagination.—It follows from this brief account of the productive process that all imaginative activity is limited by experience. To begin with, then, since production is merely an elaboration of presentative material, there can be no such thing as a perfectly new creation. The greatest imaginative genius would strive in vain to picture a wholly new colour. But, again, the processes of separation and combination are themselves conditioned and limited. When two things have always been conjoined in our experience it is impossible to picture them apart. Thus, though we may imaginatively vary the colour of an object at pleasure, we cannot picture it as having no colour at all.

Not only so, it may be said that the more uniformly two things are conjoined, the more difficult it becomes to dissociate them. Thus it is much easier to picture a moving object, as a man, apart from a definite set of local surroundings, than a stationary one, as a church. On the other hand, the mind finds it difficult to combine images as new wholes when experience suggests that the elements to be combined are incompatible. The Oriental king could not picture solid water or ice. We all find it hard to imagine persons on the other side of the globe with their feet towards ours, and yet not falling downwards. In proportion to the uniformity or invariability of the order of our experience is the difficulty of breaking up and regrouping its several parts. Hence the reason why we so easily imagine objects greatly increased in size, as the Titan or Amazon, and on the other hand greatly reduced, as the African pigmies or Swift's Lilliputians; for, as we have seen, the variation of our visual experiences with changing distance of objects is an everyday fact. In like manner, we can easily invest a thing with a new colour, as in imagining the mountain of gold, for everyday experience accustoms us to indefinite changes of colour in objects with varying illumination.

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[1] This is clearly recognised in current modes of speech, as when we talk of the eye of imagination, its far-sightedness, and so forth.

With these general and fixed limitations there are particular and temporary ones. Thus, our ability to imagine is limited by the actual sensations of the moment. We cannot look at the blue sky and *at the same moment* imagine it red. Similarly, it has been pointed out that the bodily position of the moment affects our power of imagining motor experience. Thus when lying down we find it difficult and even painful to imagine ourselves running, for the situation obstructs those nascent motor stimulations which appear to enter into the idea of running.

The reader must be careful to distinguish between the difficulty or impossibility of picturing objects, and that of understanding how they could be as we picture them. The ambiguous word "conceive," as J. S. Mill pointed out, covers both meanings. We can picture, for an instant at least, the most grotesque combinations, as Atlas carrying the earth, or a human figure poised in the air, but we cannot conceive the corresponding combinations of objects as possible. So far as the capability of merely picturing is concerned, the freaks of fancy of the young and of all of us in passive conditions of reverie and dreaming would suggest that the only limits to such pictorial combination are the incompatibilities of space and time. We cannot of course picture two objects in the same place at one moment: but our dream fancy does almost everything short of this.

Passive and Active Imagination.—It is customary to distinguish between a passive and an active process of imagination according as the changes just described are carried out unconsciously, or at least without any effort of voluntary attention, or as they involve this active factor. A word or two will serve to illustrate the distinction.

Passive imagination is that part of the unmaking and remaking which is done for us by the so-called spontaneous or mechanical workings of our psycho-physical organism. As already remarked, the images of memory tend to become transformed by a passive, unconscious, or automatic process. Thus the very imperfections of the retentive power lead to a partial or fragmentary reinstatement of percepts, and so bring about a certain amount of separation of presentative material. Thus we often recall a face without the figure, a pair of eyes apart from the face, and so forth. Again, one and the same presentation may occur at different times with dissimilar and incompatible adjunct, as when an actor is seen in different characters, or a word appears along with different contexts. In such a case the suggestive forces tend, as we have seen, to counteract one another, and thus it often happens that a partial presentation is reinstated owing to the variation and mutual inhibition of its concomitants.

These same automatic processes, moreover, would introduce a certain amount of recombination of presentative elements. If a common element A occurs in the different combinations CAB, MAP, and so forth, although we cannot at the same moment completely picture A with its two dissimilar surroundings CB and MP, the fact of the common presence of A may beget new combinations among these adjuncts, *e.g.*, MC or PB. Thus in recalling two *rôles* of an actor we are apt to find ourselves picturing a patchwork of two figures, as the cloaked form of Hamlet and the wind-driven locks of Lear.[1] That similarity does thus effect a certain regrouping of presentative complexes is clearly illustrated in our dreams, and more particularly those confused images of persons, places, and so forth, in which we can afterwards detect a partial blending of two distinct images which happen to have certain features in common.

This action of similarity is aided by the effect of plurality of suggestive stimuli, and the workings of divergent suggestion. At a given moment a number of external impressions and organic sensations may occur together for the first time, each tending to recall a separate group of images. These simultaneous tendencies will, so far as incompatible, counteract one another; yet beyond these limits a partial revival of this and of that image or image-complex may take place at such a time, and in this way we have by a purely mechanical process a new juxtaposition and grouping of elements. This process is clearly illustrated in the grotesque combinations that arise quite spontaneously in the childish mind before the habit of inhibiting these as useless has been formed. We can all find illustrations of it in the quaint fancies which occur when, in moments of idle abandon, we give full play to the suggestive forces of surrounding things, including those of people's words, and most of all, perhaps, in the strange imaginative juxtapositions of our dreams. Any emotional excitement greatly aids the formation of such novel image-groupings by increasing the rapidity and range of reproduction, and removing the inhibitory action which, under ordinary circumstances, represses all unwonted and non-significant juxtapositions of elements. Such passive production plays a large part in the imaginative creation of genius, which from the time of Plato, has commonly been regarded as largely a process of non-voluntary and unconscious "inspiration."

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[1] The recalling of a part played by different actors, say the Gringoire of M. Coquelin and of Mr. Beerbohm Tree, may produce the same result. That is to say, fragments of the form, get-up, etc., of the two representations may be reproduced together in a new grouping.

While, however, much production takes place in this unconscious or subconscious manner, the higher and more valuable forms of it involve an active regulative factor. Here, as in the case of active reproduction, we have the work of voluntary attention, the aiding of certain tendencies, and the counteracting of others, in order to reach a particular desired result. It is only when the productive process is thus controlled and guided that it becomes in the full sense what we mean by construction. For the distinguishing feature of this active process is that it is an orderly, methodical bringing together and arranging of parts in a new organic whole. Thus the poet may be said to construct when he consciously sets himself to fashion a beautiful scene, a thrilling action, and so forth, choosing material for his purpose, and gradually working up to a result that satisfies him. It is this methodical constructive process that we have now to examine.

The Process of Construction.—The first thing to be clear about in tracing out this conscious process of imaginative elaboration is that, like all elaboration, it requires as its condition the presence of certain materials. All that the most careful direction of the attention can effect is certain modifications in the spontaneous or automatic flow of images.

These materials are supplied ultimately, as we have seen, by our sense-presentations. The retention and reproduction of percepts is presupposed in all imaginative production. There is no production without reproduction. In trying to realise a scene described by a traveller or a poet I am wholly dependent on the revival of past experiences of my own. It is only when these revivals take place readily that the constructive process can advance. Hence the frequently observed fact of the vividness, rapidity, and range of reproductive ideation in the case of men of great imagination. A poet's mind must be stored with images of objects, scenes, and incidents, which can be worked up into new products.

In the second place, active production depends on the automatic regrouping of elements just described. Active and passive imagination are not wholly distinct, but the former includes the latter. As already hinted, much of the highest imaginative work of the poet is due to the action of those subconscious forces which are ever at work bringing about novel combinations of imaginative elements. The initial idea is in most, if not all, cases of such active imagination the outcome of this automatic action. We begin to picture some new scene, some new situation in life, by help of a rough draft-image which a new conjunction of circumstances, or a new combination of words directly suggests.

The conscious elaboration consists in keeping this draft-image fixed in the mind, and improving on it and developing it by the aid of such further image-material as is suggested by the special circumstances of the time. As in the case of active reproduction, the function of voluntary attention is here limited to developing and fixing or retaining certain elements, and rejecting others. Thus, in trying to imagine a new experience, say a day in a country house, a child starts with a crude idea of what it is like, based on a revival of previous analogous experiences. Keeping this idea steadily before his mind, he recalls in close connexion with it, a number of other experiences. The selective action of voluntary attention here comes in, rejecting what is recognised as unfitting and incongruous, and furthering the reinstatement of what is seen to be suitable. In this way a more elaborate image-structure gradually arises by a process of organic accretion or growth, the whole being controlled by what we call a volitional activity.

That imaginative production sets out with an outline and becomes a detailed picture by successive processes of growth, *i.e.*, a differentiation into parts and integration of these into an organic whole, has been recognised by more than one psychologist. This process of gradual determination by development of detail is not confined to constructive imagination. There is something very like it in a good deal of perception, which begins with a vague general impression and gradually grows into a clear discriminative perception of this particular object. Similarly, in the process of reproduction, we frequently recover a vague idea of a person, a word, and so forth, before we reinstate the complete image. We may say, indeed, that all processes of presentation and representation are a transition from a vague incomplete or indefinite to a clear complete and definite form, that is to say, are processes having the characteristics of all development.

It is evident from our brief analysis of the constructive process that its due regulation depends upon a clear sense or judgment of what is fitting for the purpose in hand. It is, indeed, the degree of fineness of this guiding sense which principally determines the success of the whole operation. According as a poet, for example, has a clear and discriminating, or a dull and obtuse, sense of what is aesthetically valuable, congruous, or harmonious, so will his constructive work be well or ill performed.

This guiding sense must be distinguished from the desire for an end, though they are closely related. A man may have a keen desire to compass some result, *e.g.*, a mechanical improvement, but no corresponding sense of what is fitting to bring it about. Hence the strength of the desire, though an important factor in sustaining the active effort of construction, is less important than the sense of fitness.

The result aimed at, and the corresponding guiding sense of fitness, will differ in different cases. In reading a book of travels, for example, we seek to frame clear mental pictures which fit in with the rest of the series; and we know when we have hit on the right combination of images in this case by a consciousness of the consistency of the grouping and of its agreement with the facts of our experience, in other words, by a feeling of satisfaction which comes of *understanding* what we read. On the other hand, in combining movements in order to bring about a wished-for practical end, we are guided by a sense of what is feasible, and what will conduce to the desired end.

EXERCISE

1. State in one hundred words or less the main facts about imagination brought out in the foregoing passage.

2. IMAGINATION IN SCIENCE[1]

BY KARL PEARSON

Disciplined imagination has been at the bottom of all great scientific discoveries. All great scientists have, in a certain sense, been great artists; the man with no imagination may collect facts, but he cannot make great discoveries. If I were compelled to name the Englishmen who during our generation have had the widest imaginations and exercised them most beneficially, I think I should put the novelists and poets on one side and say Michael Faraday and Charles Darwin. Now it is very needful to understand the exact part imagination plays in pure science. We can, perhaps, best achieve this result by considering the following proposition: Pure science has a further strong claim upon us on account of the exercise it gives to the imaginative faculties and the gratification it provides for the aesthetic judgment. The exact meaning of the terms "scientific fact" and "scientific law" cannot be considered here, but for the present let us suppose an elaborate classification of such facts has been made, and their relationships and sequences carefully traced. What is the next stage in the process of scientific investigation? Undoubtedly it is the use of the imagination. The discovery of some single statement, some brief *formula* from which the whole group of facts is seen to flow, is the work, not of the mere cataloguer, but of the man endowed with creative imagination. The single statement, the brief formula, the few words of which replace in our minds a wide range of relationships between isolated phenomena, is what we term a scientific *law*. Such a law, relieving our memory from the burden of individual sequences, enables us, with the minimum of intellectual fatigue, to grasp a vast complexity of natural or social phenomena. The discovery of law is therefore the peculiar function of the creative imagination. But this imagination has to be a *disciplined* one. It has in the first place to appreciate the whole range of facts, which require to be resumed in a single statement; and then when the law is reached—often by what seems solely the inspired imagination of genius—it must be tested and criticised by its discoverer in every conceivable way, till he is certain that the imagination has not played him false, and that his law is in real agreement with the whole group of phenomena which it resumes. Herein lies the keynote to the scientific use of the imagination. Hundreds of men have allowed their imagination to solve the universe, but the men who have contributed to our real understanding of natural phenomena have been those who were unstinting in their application of criticism to the product of their imaginations. It is such criticism which is the essence of the scientific use of the imagination, which is, indeed, the very life-blood of science.[1]

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[1] Adapted from *The Grammar of Science*, pp. 30–31. London: Adam Charles Black, 1911.

EXERCISE

1. Show how imagination is important in industry, war, politics, or sport.

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[1] *La critique est la vie de la science*, says Victor Cousin.

3. DAY-DREAMS

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BY ALEXANDER BAIN

We all know what is meant by day-dreaming, castle-building, and such like terms; as implying that one finds scope in an imaginary world for the gratification of longings that are not answered by anything in the realities of one's lot. This method of proceeding, however, is not of the same universal application as the preceding; it is not every desire that can be even partially satisfied by imaginary outgoings. If, for example, we take any of the bodily appetites—hunger, thirst, sleep, &c., or any of the other organic sensations—heat, cold, nervous depression, we find that no ideal or imagined relief is of and practical avail:—

> Who can hold a fire in his hand
> By thinking on the frosty Caucasus?

On the other side, the craving for a return of scenes and days of bygone pleasure, sometimes contains so much of the "pleasure of memory" of the foregone emotions, as to make imagination to a great degree satisfying. So, when any one has deeply offended us, being yet beyond the reach of our retaliation, we have still some fraction of the full measure of revenge, by going over in the mind what we should do if the offender were to cross our path. Any sentiment that is naturally luxuriant in the constitution, being not likely to be met in all its fulness by the reality, makes up for the defect by a series of ideal volitions corresponding to its demands. The sentiment of power is a signal example of this. Each one whose sphere falls below what this feeling leads him to wish, finds in imagined domains an outlet for the insatiable craving; and such may be the peculiarity of the individual, that empire in conception may go some way to supply the void.

The comparison now instituted between the physical wants and certain of the emotions or sentiments, suggests at once what the circumstance is that enables us to find gratification or relief in imaginary actions. A feeling persisting after the fact, or recovered by mere association, without the presence of the proper stimulus, can sometimes approach the fulness of the real experience; so much so, that we are content in many instances with this bare conception, or ideal resuscitation. The recollection of a time of gaiety and excitement, of some interesting conversation or discourse, or of a book that we have read, may give such an amount of the feeling of actual experience that we rest satisfied with that, and wish nothing further. On a matter, therefore, where we have a power of restoring mentally the full-toned delight of a real experience, it is easy to convert memory into imagination, and to construct future gratifications of the same sort, with or without a basis of reality. We speak occasionally of such and such a one having a strong imagination, when we mean that he can so body forth an ideal pleasure, as to derive from it an entire satisfaction of the want of the moment. In the physical cravings, this is an impossibility Something may be done to stave off for a little the insupportable agony of thirst, hunger, drowsiness, or cold, or to lull the acute pinch of a neuralgic pain; but the actual in these cases is too strong for the most highly stimulated counter-ideal. We have thus two opposite extremes among our multitudinous sensibilities; one where actuality alone can fill up the aching void, the other where the mere idea amounts to the full demands of the system; and between those extremes lies the whole range of imaginary volition, put in motion at the instance of pains or pleasures, such as we cannot work for in the regular compass of our voluntary exertion.

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[1] Adapted from *The Emotions and the Will* (3d ed.), pp. 427–32. London: Longmans, Green, & Co., 1888.

So wide is the operation of these ideal outgoings, that the chief difficulty lies in selecting a good instance to show how faithfully a course of voluntary action is repeated in the idea. Take the desire of Wealth. The motive growing out of pleasure secured, and pain turned aside, by worldly abundance, stimulates, perhaps, the largest share of the activity of mankind. To work, to husband the fruits of toil, to combine intelligence with handicraft, to exercise self-denial, and surmount the love of ease,—are the genuine manifestations of our volitional nature under this cumulative end. The motive, however, may exist, where the means of attainment are, from various causes, restricted. A man may feel very keenly the sufferings that wealth could alleviate, and many have an appetizing conception of pleasures that it could command, but may be so situated as to be unable to compass the desirable object. It is then that imagination overleaps the barrier, and fills the mind with the ideas of those transactions that in other circumstances would be reproduced in reality. If the young man's obstacle at starting is the want of a certain capital to trade upon, his imaginings take the form of chalking out his line of operations, were he in actual possession of the amount desiderated. If the difficulty is to obtain a certain office exactly adapted to his abilities, he is occasionally led to assume this difficulty overcome, and to sketch in his mind the active proceedings consequent thereon. It is still the stimulus of volition that is the prime mover of the activity; and the activity itself is essentially voluntary, although transferred from the actual operations, to the ideal rehearsal of them. This ideal volition is, in point of fact, an essential prelude to the lifting of the hand, and the performing of the actual business as it arises. The man that has gained his capital, or his office, has to spend a certain time in the mental work of deliberation under conflicting impulses, before taking the real proceedings; and the dreamer, moved by the same original motives, goes through these ideal preliminaries, even when they can end in nothing real.

The tender affections, complacency, honour, and the sentiment of power, as existing in the average of persons, are all suited to imaginary activity. So are the artistic feelings, and the love of knowledge. But there is, perhaps, hardly any sensibility of human nature that may not prove a basis for day-dreaming in some minds; while in many cases the feelings now mentioned may fail in that respect. It may give no pleasure at all to imagine the recovery of a lost friend, or to dream of fame, fortune, and power. As mere ideas, these may fail to bring on an agreeable glow; they may simply reproduce the pain of privation, as when we suffer fatigue, hunger, or cold. There is, moreover, a sentiment of our nature that revolts from excessive ideality, namely, the dislike to extreme disparity of the ideal and the actual. In minds alive to the contradiction, the suffering that it gives is so acute, as to be a motive power hostile to the outgoings of the mind in vain imaginings. We call this a healthy check, from the fact that the duties and the interests of life are put in peril by the license of roaming desire.

It is easy to understand how Pain generates avoidance in the ideal as well as in the actual. The only requisite is that the recollection of the painful quality be tolerably vivid, as when we earnestly reflect how to keep at a distance penury or shame. But as regards the motives from Pleasure, there is something to be explained. If I have in my mind the vivid conception of some favourite delight—as of music, spectacle, or social intercourse,—why should I not remain content with what I remember of it? It is quite true that there may be still higher degrees of gratification than mine, but such would be the case, whatever felicity I might attain to. This leads us to consider more closely the nature of that state of mind wherein a pleasure in idea craves to become one in reality. There must be something in it different from the mere impulse to add to a present delight up to full satiety. It is a fact that I am much more satisfied with a plain and moderate meal than with the imagination of a feast. There would seem to be a certain pain mixed up with imagined good, resembling the pain of a bodily craving.

We are sometimes said to set our heart upon a particular enjoyment; which is a mode of signifying that we have been worked up to such a condition respecting it, as to feel the deprivation to be a real want of the system. The desire of pleasure, in this sense, contains in it the mental sting of an acute suffering. We are thus brought back to the great distinction made above between pleasures whose memory or conception is satisfying, and pleasures of an opposite sort. In cases where we can remember that we were at a certain time very much elated, but where the remembrance contains in itself no elation whatsoever, there starts up a painful feeling urging us to realize that time again, even though the entertaining of the mere remembrance is an empty notion. We can take hold of a past emotion by a present effort of the intellect, so as to recognize intellectually the distinguishing qualities of it—to compare it with others agreeing or disagreeing with it, while yet nothing of the genuine thrill is reproduced. It is in such a predicament, that volition and desire are roused by a motive power that we may concede as in part made up of pleasure—namely, the very small share that still clings to the memory, or notion,—but that, I believe, springs mostly out of the pain of so imperfect a realization of what we know to have been a state of high delight. The ardent Greek, remembering the excitement of an Olympic gathering, has a certain elated feeling stirred up by the mere remembrance; but at the same time he recognizes the great difference between his present tone of enjoyment and that full tide of hilarious glee that belonged to the days of the great celebration; and it is upon this sense of difference that he is moved to be present at another festival, or failing that, to visit it in imagination. The pleasurable part of the state urges the will for an additional draught; the sense of the shortcoming of the recollection is of the nature of a pain, and operates for its own removal. If that amount of excitement stirred up by the memory of some happy day gone by, could exist in the mind without any comparative reference, we might probably feel gladdened, without any spur of desire; it is the idea of still greater delights that mars the peace of the mind.

B[1]

BY EDWARD S. ROBINSON

The distinction between play and fantasy is, of course, a distinction between overt and ideational behavior. Play, in so far as it is pretending, is never without an element of fantasy, but we may arbitrarily confine the application of the latter term to those forms of pretending which are lacking in overt bodily accompaniments. It will then be possible to distinguish between these two and to note their interrelations.

Although we cannot be certain of it, play probably precedes fantasy in the child's life. The latter does appear quite early, however, in some children at least, and before the school age is reached both are clearly present. I remember the interesting evidence for the early rise of fantasy given to me by a little girl of not more than four, who said, placing her two chubby hands before her face, "Let's shut our eyes and play we're at Gran'ma's."

In play and fantasy there are two factors, which may or may not be consciously recognized by the child, determining to a large extent the nature of his pretending activities. In the first place, there is a tendency toward breadth and freedom of expression. The child must express impulses which are often clearly incongruous with his world of actuality, and the greater this incongruity the more lively will be the flights of imagination to which they give rise and the more apt will the child be to engage in private fantasy rather than in overt play. In the second place, the satisfaction which is derived from compensatory behavior depends to some extent upon its being within the limits of the child's own credulity. The impulses which drive the child are aimed at an actual world, and their indirect expression itself must not get too far beyond the realms of that actuality. Thus, we may think of these two main determinants of play and fantasy as (1) the child's natural tendency toward free expression, and (2) his need for a certain credibility in experience.

The tendency toward free expression leads to the establishment of all sorts of fictitious characters and objects within the playground. Toys and playmates which do not fit in with the completer, fancied world may be put aside. I remember that even up to the age of sixteen, I frequently judged congeniality in terms of the readiness of others to disregard reality in favor of a world of pretty definite and well defined fancy. I always preferred to *knock grounders* with one particular lad because he co-operated so well in converting the procedure into the pretensions of a *big league* game. The same was true in boxing. Having read and memorized the details of most of the historic ring battles, we repeated many of these almost blow for blow upon the floor of my mother's laundry. And many were the Harvard-Yale football games in which I engaged with one other actual player, both of us, as often as not, playing on the same side. In cases of this sort, the meaning of ordinary play activity is widened by the liberal use of fantasy.

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[1] Adapted from "The Compensatory Function of Make-Believe Play," *Psychological Review*, XXVII (1920), 434–38.

In the course of an individual's development many impulses arise which can not be expressed to any satisfactory extent in a co-operative fashion. Often a child is afraid of being laughed at for the world he would live in. Under such circumstances there may be a withdrawal from play to pure fantasy with its wider possibilities for pretending. Indeed, one of the signs of coming adulthood is the giving up of overt play and the switching over to compensatory behavior of a more private sort. Adults seldom play in the childhood sense of that term, unless it be in art. In the adult, compensations through pretending are more likely to be worked out in private day-dreams. The fact remains, however, that less compensation of any kind is necessary in the general run of adult lives, so that we may safely assume that fantasy as well as play is more common during childhood.

Along with this tendency toward free expression, we have a tendency to make that expression as realistic as possible. Children are constantly recognizing inconsistencies in their play life and trying to patch them over as best they can. When, as a very small boy, I played with tin soldiers and miniature locomotives, I always felt the inappropriateness of the size of my own body. The device which I hit upon to get around this difficulty I called *Playing You Are Nothing*. Every playfellow who entered into the world of my tiny armies and railroads was introduced to the proposition of suspending all interest in his own body. The running of the trains and the marching of the troops were to be considered as events independent of ourselves. There was one youngster who could not push a locomotive across the floor without playing *he* was the engineer. His fate was obvious. I never invited him to play unless I could get no one else; and, when he did come, it was to be made miserable by my constant insistence that he must play he was nothing. Our disagreement, of course, grew out of the fact that each of us in his own way was striving to give the play a more vivid atmosphere of reality.

Just as overt play often passes over into private fantasy owing to a struggle against the limitations of the actual social and physical world, so private fantasy often passes over into overt play in the interests of greater credibility. As a child I was full of baseball fantasies. Although I played baseball a great deal, these games did not satisfy certain standards set up by reading athletic stories and watching older and more skillful players. But the fantasies, too, often became unsatisfactory on account of their intangibility. As a result I formed the habit of laying out a diamond upon the lawn and there, without ball or playmates, carrying out the overt movements of an heroic baseball performance. Many a time, I pitched nine long innings to baffled athletes who swung immaterial bats at my imaginary curves. Here was fantasy improved and made realistic by the actuality of its muscular accompaniments.

The topics of private fantasy are perhaps even more apt to find increased tangibility by being brought into contact with a real social world. The child knows that his day-dreams are unreal, but the insistence of that fact becomes less troublesome if only he can get someone else to believe or act as though he believes in the reality of those imagined events. Many of the lies of children arise out of such circumstances. A boy longs for a pony and a box of tools. He fancies these things in his possession, and before a great while he somehow feels driven to tell his friends either that he already has the things he desires or that he has been promised them. An acquaintance of mine spent her earliest years on a farm which was more or less out of touch with the livelier affairs of the world. Now it so happened that an older sister in this household was sent to town to finish her education. Upon her return she had much to say of her experiences. These tales thrilled the younger sister and stimulated her to day-dreaming. Soon after this the little girl began her own education at a neighboring country school. As she tells of it now, almost her first intercourse with her school mates was marked by her own spectacular reports of what *she* had seen and heard while sojourning in the town which really she had never been near.

It is interesting to note here that the literary make-believe of adults contains within it evidence of the tendencies toward free expression and credibility, which I have mentioned as such significant factors in child life. Written fiction, for example, may be thought of as an instrument for free expression and the spoken drama as an instrument for giving human fancies increased tangibility. It is hardly necessary to point out the importance of artistic appreciation and production for the imaginative life of children.

EXERCISES

1. Describe a case of day-dreaming, of playing, and of lying, and indicate the circumstances that gave rise to them.
2. Which of the arts are most evidently related to day-dreaming, playing, and lying?

4. DREAMS IN SLEEP[1]

BY R. MACNISH

I believe that dreams are uniformly the resuscitation or re-embodiment of thoughts which have formerly, in some shape or other, occupied the mind. They are old ideas revived either in an entire state, or heterogeneously mingled together. I doubt if it be possible for a person to have, in a dream, any idea whose elements did not, in some form, strike him at a previous period. If these break loose from their connecting chain, and become jumbled together incoherently, as is often the case, they give rise to absurd combinations; but the elements still subsist, and only manifest themselves in a new and unconnected shape. As this is an important point, and one which has never been properly insisted upon, I shall illustrate it by an example. I lately dreamed that I walked upon the banks of the Great Canal in the neighbourhood of Glasgow. On the side opposite to that on which I was, and within a few feet of the water, stood the splendid portico of the Royal Exchange. A gentleman, whom I knew, was standing upon one of the steps, and we spoke to each other. I then lifted a large stone, and poised it in my hand, when he said that he was sure I could not throw it to a certain spot which he pointed out. I made the attempt, and fell short of the mark. At this moment, a well known friend came up, whom I knew to excell at *putting* the stone; but, strange to say, he had lost both his legs and walked upon wooden substitutes. This struck me as exceedingly curious; for my impression was that he had only lost one leg, and had but a single wooden one. At my desire he took up the stone, and, without difficulty, threw it beyond the point indicated by the gentleman upon the opposite side of the canal. The absurdity of this dream is extremely glaring; and yet, on strictly analyzing it, I find it to be wholly composed of ideas, which passed through my mind on the previous day, assuming a new and ridiculous arrangement. I can compare it to nothing but to cross readings in the newspapers, or to that well known amusement which consists in putting a number of sentences, each written on a separate piece of paper, into a hat, shaking the whole, then taking them out one by one as they come, and seeing what kind of medley the heterogeneous compound will make when thus fortuitously put together. For instance, I had, on the above day, taken a walk to the canal along with a friend. On returning from it, I pointed out to him a spot where a new road was forming, and where, a few days before, one of the workmen had been overwhelmed by a quantity of rubbish falling upon him which fairly chopped off one of his legs, and so much damaged the other that it was feared amputation would be necessary. Near this very spot there is a park in which, about a month previously, I practised throwing the stone. On passing the Exchange on my way home, I expressed regret at the lowness of its situation, and remarked what a fine effect the portico would have were it placed upon more elevated ground. Such were the previous circumstances, and let us see how they bear upon the dream.

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[1] Adapted from *The Philosophy of Sleep*, pp. 36–48. London: W. R. McPhun, 1862.

In the first place, the canal appeared before me. 2. Its situation is an elevated one. 3. The portico of the Exchange, occurring to my mind as being placed too low, became associated with the elevation of the canal, and I placed it close by on a similar altitude. 4. The gentleman I had been walking with was the same whom, in the dream, I saw standing upon the steps of the portico. 5. Having related to him the story of the man who lost one limb, and had a chance of losing another, this idea brings before me a friend with a brace of wooden legs, who, moreover, appears in connection with *putting* the stone, as I know him to excell at that exercise. There is only one other element in the dream which the preceding events will not account for, and that is, the surprise at the individual referred to having more than one wooden leg. But why should he have even one, seeing that in reality he is limbed like other people? This also I can account for. Some years ago, he slightly injured his knee while leaping a ditch, and I remember of jocularly advising him to get it cut off. I am particular in illustrating this point with regard to dreams, for I hold, that if it were possible to analyze them all, they would invariably be found to stand in the same relation to the waking state as the above specimen. The more diversified and incongruous the character of a dream, and the more remote from the period of its occurrence the circumstances which suggest it, the more difficult does its analysis become; and, in point of fact, this process may be impossible, so totally are the elements of the dream often dissevered from their original source, and so ludicrously huddled together. This subject shall be more fully demonstrated in speaking of the remote causes of dreams.

Dreams generally arise without any assignable cause, but sometimes we can very readily discover their origin. Whatever has much interested us during the day, is apt to resolve itself into a dream; and this will generally be pleasurable, or the reverse, according to the nature of the exciting cause. If, for instance, our reading or conversation be of horrible subjects, such as spectres, murders, or conflagrations, they will appear before us magnified and heightened in our dreams. Or if we have been previously sailing upon a rough sea, we are apt to suppose ourselves undergoing the perils of shipwreck. Pleasurable sensations during the day are also apt to assume a still more pleasurable aspect in dreams. In like manner, if we have a longing for anything, we are apt to suppose that we possess it. Even objects altogether unattainable are placed within our reach; we achieve impossibilities, and triumph with ease over the invincible laws of nature.

Dreams often arise from the impressions made upon the senses during sleep. Dr. Beattie speaks of a man on whom any kind of dream could be induced, by his friends gently speaking in his presence upon the particular subject which they wished him to dream about. I have often tried this experiment upon persons asleep, and more than once with a like result. I apprehend, that when this takes place, the slumber must have been very imperfect. With regard to the possibility of dreams being produced by bodily impressions, Dr. Gregory relates, that having occasion to apply a bottle of hot water to his feet when he went to bed, he dreamed that he was making a journey to the top of Mount Etna, and that he found the heat of the ground almost insufferable. Another person having a blister applied to his head, imagined that he was scalped by a party of Indians; while a friend of mine happening to sleep in damp sheets, dreamed that he was dragged through a stream. Another friend dreamed that he was stroking a kitten, which in consequence purred most lustily. On awaking, he found that the working of the heavy machinery of a neighbouring mill was slightly shaking his bed, and making the joints produce a sound like the purring of a cat. A paroxysm of gout during sleep has given rise to the person supposing himself under the power of the Inquisition, and undergoing the torments of the rack. The bladder is sometimes emptied during sleep, from the dreaming idea being directed (in consequence of the unpleasant fullness of the viscus) to this particular want of nature. These results are not uniform, but such is the path in which particular bodily states are apt to lead the imagination; and dreams occurring in these states will more frequently possess a character analogous to them than to any other—modified, of course, by the strength of the individual cause, and fertility of the fancy.

Some curious experiments in regard to this point, were made by M. Girou de Buzareingues, which seem to establish the practicability of a person determining at will the nature of his dreams. By leaving his knees uncovered, he dreamed that he travelled during night in a diligence: travellers, he observes, being aware that in a coach it is the knees that get cold during the night. On another occasion, having left the posterior part of his head uncovered, he dreamed that he was present at a religious ceremony performed in the open air. It was the custom of the country in which he lived to have the head constantly covered, except on particular occasions, such as the above. On awaking, he felt the back of his neck cold, as he had often experienced during the real scenes, the representation of which had been conjured up by his fancy. Having repeated this experiment at the end of several days, to assure himself that the result was not the effect of chance, the second vision turned out precisely the same as the first. Even without making experiments, we have frequent evidence of similar facts; thus, if the clothes chance to fall off us, we are liable to suppose that we are parading the streets in a state of nakedness, and feel all the shame and inconvenience which such a condition would in reality produce. We see crowds of people following after us and mocking our nudity; and we wander from place to place seeking a refuge under this ideal misfortune. Fancy, in truth, heightens every circumstance, and inspires us with greater vexation than we would feel if actually labouring under such an annoyance. The streets in which we wander are depicted with the force of reality; we see their windings, their avenues, their dwelling-places, with intense truth. Even the inhabitants who follow us are exposed to view in all their various dresses and endless diversities of countenance. Sometimes we behold our intimate friends gazing upon us with indifference, or torturing with annoying impertinence. Sometimes we see multitudes whom we never beheld before; and each individual is exposed so vividly, that we could describe, or even paint his aspect.

In like manner, if we lie awry, or if our feet slip over the side of the bed, we often imagine ourselves standing upon the brink of a fearful precipice, or falling from its beetling summit into the abyss beneath.[1] If the rain or hail patter against our window, we have often the idea of a hundred cataracts pouring from the rocks; if the wind howl without, we are suddenly wrapt up in a thunder-storm, with all its terrible associations; if the head happen to slip under the pillow, a huge rock is hanging over us, and ready to crush us beneath its ponderous bulk. Should the heat of the body chance to be increased by febril irritation or the temperature of the room we may suppose ourselves basking under the fiery sun of Africa; or if, from any circumstance, we labour under a chill, we may then be careering and foundering among the icebergs of the pole, while the morse and the famished bear are prowling around us, and claiming us for their prey. Dr. Beattie informs us, that once, after riding thirty miles in a high wind, he passed the night in visions terrible beyond description. The extent, in short, to which the mind is capable of being carried in such cases, is almost incredible. Stupendous events arise from the most insignificant causes—so completely does sleep magnify and distort everything placed within its influence. The province of dreams is one of intense exaggeration—exaggeration beyond even the wildest conceptions of Oriental romance.

A smoky chamber, for instance, has given rise to the idea of a city in flames. The conflagrations of Rome and Moscow may then pass in terrific splendour before the dreamer's fancy. He may see Nero standing afar off, surrounded by his lictors and guards, gazing upon the imperial city wrapt in flames: or the sanguinary fight of Borodino, followed by the burning of the ancient capital of Russia, may be presented before him with all the intenseness of reality. Under these circumstances, his whole being may undergo a change. He is no longer a denizen of his native country, but of that land to which his visions have transported him. All the events of his own existence fade away; and he becomes a native of Rome or Russia, gazing upon the appalling spectacle.

On the other hand, the mind may be filled with imagery equally exaggerated, but of a more pleasing character. The sound of a flute in the neighbourhood may invoke a thousand beautiful and delightful associations. The air is, perhaps, filled with the tones of harps, and all other varieties of music—nay, the performers themselves are visible; and while the cause of this strange scene is one trivial instrument, we may be regaled with a rich and melodious concert. For the same reason, a flower being applied to the nostrils may, by affecting the sense of smell, excite powerfully the imagination, and give the dreamer the idea of walking in a garden.

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[1] Dr. Currie, in allusion to the visions of the hypochondriac, observes, that if he dream of falling into the sea, he awakes just as the waters close over him, and is sensible of the precise gurgling sound which those experience who actually sink under water. In falling from heights, during dreams, we always awake before reaching the ground.

There is one fact connected with dreams which is highly remarkable. When we are suddenly awaked from a profound slumber by a loud knock at, or by the rapid opening of, the door, a train of actions which it would take hours, or days, or even weeks to accomplish, sometimes passes through the mind. Time, in fact, seems to be in a great measure annihilated. An extensive period is reduced, as it were, to a single point, or rather a single point is made to embrace an extensive period. In one instant, we pass through many adventures, see many strange sights, and hear many strange sounds. If we are awaked by a loud knock, we have perhaps the idea of a tumult passing before us, and know all the characters engaged in it—their aspects, and even their very names. If the door open violently, the flood-gates of a canal may appear to be expanding, and we may see the individuals employed in the process, and hear their conversation, which may seem an hour in length. If a light be brought into the room, the notion of the house being in flames perhaps invades us, and we are witnesses to the whole conflagration from its commencement till it be finally extinguished. The thoughts which arise in such situations are endless, and assume an infinite variety of aspects. The whole, indeed, constitutes one of the strangest phenomena of the human mind, and calls to recollection the story of the Eastern monarch, who, on dipping his head into the magician's water-pail, fancied he had travelled for years in various nations, although he was only immersed for a single instant. This curious psychological fact, though occurring under somewhat different circumstances, has not escaped the notice of Mr. De Quincey, better known as the "English Opium-Eater." "The sense of space," says he, "and, in the end, the *sense of time*, were both powerfully affected. Buildings, landscapes, &c., were exhibited in proportions so vast as the bodily eye is not fitted to receive. Space swelled, and was amplified to an extent of unutterable infinity. This, however, did not disturb me so much as the expansion of time. I sometimes seemed to have lived for seventy or a hundred years in one night; nay, sometimes had feelings representative of a millenium passed in that time, or, however, of a duration far beyond the limits of any human experience."

Every person must have experienced this apparent expansion of time in his visions. I lately dreamed that I made a voyage to India—remained some days in Calcutta—returned home—then took ship for Egypt, where I visited the cataracts of the Nile, Grand Cairo, and the Pyramids: and, to crown the whole, had the honour of an interview with Mehemet Ali, Cleopatra, and Alexander the Great. All this was the work of a single night, probably of a single hour, or even a few minutes; and yet it appeared to occupy at least twelve months.

I must also mention another circumstance of a somewhat similar kind, which, though it occur in the waking condition, is produced by the peculiar effect of previous sleep upon the mind. Thus, when we wake in a melancholy mood, the result probably of some distressing dream, the remembrance of all our former actions, especially those of an evil character, often rushes upon us as from a dark and troubled sea. They do not appear individually, one by one, but come linked together in a close phalanx, as if to take the conscience by storm, and crush it beneath their imposing front. The whole span of our existence, from childhood downwards, sends them on; oblivion opens its gulfs and impels them forwards; and the mind is robed in a cloud of wretchedness, without one ray of hope to brighten up its gloom. In common circumstances, we possess no such power of grouping so instantaneously the most distant and proximate events of life; the spell of memory is invoked to call them successively from the past; and they glide before us like shadows, more or less distinct according to their remoteness, or the force of their impress upon the mind. But in the case of which I speak, they start abruptly forth from the bosom of time, and overwhelm the spirit with a crowd of most sad and appalling reminiscences. In the crucible of our distorted imagination, everything is exaggerated and invested with a blacker gloom than belongs to it; we see at one glance down the whole vista of time; and each event of our life is written there in gloomy and distressing characters. Hence the mental depression occurring under these circumstances, and even the remorse which falls, like bitter and unrefreshing dews, upon the heart.

We have seldom any idea of past events in dreams; if such are called forth, they generally seem to be present, and in the process of actual occurrence. We may dream of Alexander the Great, but it is as of a person who is co-existent with ourselves.

Persons who have a strong passion for music often dream of singing and composing melodies; and the ideas of some of our finest pieces are said to have been communicated to the musician in his sleep. Tartini, a celebrated violin player, is said to have composed his famous *Devil's Sonata* from the inspiration of a dream, in which the Devil appeared to him, and challenged him to a trial of skill upon his own fiddle. A mathematician, in like manner, is often engaged in the solution of problems, and has his brain full of Newton, Euler, Euclid, and Laplace; while a poet is occupied in writing verses, or in deliberating upon the strains of such bards as are most familiar to his spirit: it was thus in a dream that Mr. Coleridge composed his splendid fragments of Kubla Khan. Some authors assert that when the mind has been strongly impressed with any peculiar ideas, such are less likely to occur in dreams than their opposites; but this is taking the exception for the general rule, and is directly at variance with both experience and analogy. In fact, whatever propensities or talents are strongest in the mind of the individual, will, in most cases, manifest themselves with greatest readiness and force in dreams; and where a faculty is very weak, it will scarcely manifest itself at all. Thus, one person who has large *Tune* and small *Causality* will indulge in music, but seldom in ascertaining the nature of cause and effect; while another, with a contrary disposition of organs, may attempt to reason upon abstract truths, while music will rarely intrude into the temple of his thoughts. It is but fair to state, however, that the compositions, the reasonings, and the poems which we concoct in sleep, though occasionally superior to those of our waking hours, are generally of a very absurd description; and, how admirable soever they may have appeared, their futility is abundantly evident when we awake. To use the words of Dr. Parr, "In dreams we seem to reason, to argue, to compose; and in all these circumstances during sleep, we are highly gratified, and think that we excel. If, however, we remember our dreams, our reasonings we find to be weak, our arguments we find to be inconclusive, and our compositions trifling and absurd." The truth of these remarks is undeniable; but the very circumstance of a man's dreams turning habitually upon a particular subject—however ridiculously he may meditate thereupon—is a strong presumption that that subject is the one which most frequently engrosses his faculties in the waking state: in a word, that the power most energetic in the latter condition is that also most active in dreams.

EXERCISE

1. Analyze a dream and demonstrate the relation of its elements to past experience, to desires or fears, and to sensory stimuli present at the time of dreaming.

5. DREAMS IN DROWSINESS[1]

BY H. L. HOLLINGWORTH

Conceivably the state of drowsiness might throw considerable light on dream formation, the relation between the latent and the manifest content of dreams, and the various ways in which external impressions and central dispositions are transformed and related in the serial dream. Drowsiness is the transition state between waking consciousness and dream life, and careful observation of this state should be able to catch dreams in the making and to disclose the tendencies which attain their maximal operation in the sleep state proper. Whether or not it be true that the genuine dream is experienced only in moments of awaking from or falling into the sleep state is immaterial. The dream as a more or less systematic articulation and fabrication is quite distinguishable from the unique fusions which come in moments of drowsiness. In the experience of the writer and his observers these latter are more often momentary perceptual states, flashlights of imagery of unwonted vividness which may as such be repeated in successive moments but which do not tend to lead on to new situations as do dream states. And yet these perceptual fusions show striking points of similarity in their composition to the various units of the serial dream.

The purpose of this paper is to describe several typical cases of the drowsiness hallucination and to analyze out some of the principles which clearly contribute to their formation. Two observers, the writer (H) and his wife (L), have for the last two years been recording these experiences, with the result that an accumulation of cases has been acquired which seem to show sufficiently pronounced characteristics and similiarities to make their discussion worth while. The observations have invariably been made in the pre-sleeping state, for neither of the observers has the drowsiness hallucination in any marked degree in the pre-waking state. In all cases the observer has been aware of the hallucinatory character of the experience, and has immediately written out the description or narrated it to the other observer.

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[1] Adapted from "The Psychology of Drowsiness," *American Journal of Psychology*, XXII (1911), 100–104.

The imagery type of the observer, as will be shown later, seems to be to some extent, a determining factor in the composition of the hallucination content, in that modes which are only vague and seldom used in the waking state become vivid and active in the drowsy condition, while the type modes fall into the background. It will then be of interest to know that according to frequent imagery tests L is predominately visual and visual-verbal in type with almost no auditory or motor tendencies, while H is very highly auditor-motor, both as to imagery and memory type, has frequently had auditory and motor hallucinations, especially marked in childhood, but is a very poor visualizer. Typical cases are given in the following paragraphs.

Case I. Observer H. On board ocean-liner, dressing for dinner in suit purchased abroad, sitting drowsily on edge of berth and thinking that the suit had turned out to be a bad investment and had been forced on to me by a tricky salesman. Planning to buy cloth this time to be made up in United States and wondering if it would pass Customs. Suddenly the rush of water heard through porthole becomes transformed into the husky voice of a salesman trying to sell me a suit. I fall to musing in the process, wondering, while he talks, at his husky voice and why he has no more inflection.

Case II. Observer H. At Victor Herbert's opening concert, 1909, L—, E—, and myself were talking of the cartoons of Mr. Bug in "Life." L— described a cartoon in which the six legs of Deacon Fire-fly were represented as grasping different objects such as a Bible, a prayer book, etc., while Mr. Bug held playing cards, a bottle, a cigar, etc. I had been working all day on comparative nervous anatomy, preparing a lecture on complications of stimulus and response, and had my head full of segments and nervous arcs. The orchestra played Grieg's "Wedding Day at Hegstad." In the last bar there were three finishing blasts with full orchestra. I had become very drowsy and these blasts seemed to me to be movements of some huge bug which came sailing from behind the wings, suddenly alighting on the stage, first on the two hind feet, then bringing down the middle pair, and finally the two front feet with the final blast. The visual elements present were of huge, vague, rather reddish brown jointed legs, the feet not clear and only the lower ventral side of the body dimly suggested, but flashing out at each "land" of the feet.

Case III. Observer H. In bed, winter '09, with "grippe." Kept tossing from side to back, then to other side. As I tossed the numbers 50, 2, 36 kept running in my head, appearing clearly visually as 5236, and auditorially as "fifty two—thirty six." Now these (50, 2, 36) were the combination numbers of my gym locker, which I opened by turning the knob left-right-left-right four turns, very much as I now tossed in bed. In my tossing the numbers rang and rang in my head, the left side seeming 52, the right side 36, the back 5236. It seemed that if I could juggle these numbers into the right combination I could find a comfortable position.

Case IV. Observer L. Tossing experience similar to above, but seemed to be going to Brooklyn and back, Mrs. M.— who lives there having lately been uppermost in mind through conversation, letters and a recent visit.

Case V. Observer H. Played checkers nearly all day on steamer. Retiring to cabin before sleeping time, threw myself drowsily on my bunk and fell to ruminating over some projected experiments on the comic, wondering whether to follow method of order of merit or that of assigning numerical grade to each comic situation. I decide, but in my half awake consciousness the decision takes the form of a move in checkers. I decide to move my white man up to the king row and mentally see C— jump it with his black.

Case VI. Observer H. Lying in bed talking. In a pause I see a large marble toad-stool which seems to stand on a hill and to resemble the dome of the New York University Library, around which runs the Hall of Fame. On top of the toad-stool bell were stamped in large black letters three names, "Jastrow," "Gillis," and another blurred one which I could not make out. At once I told my companion of the vision, saying "I see a curious hall of fame," etc. That evening I had read some comments on Jastrow's magazine article on "Malicious Animal Magnetism" and had also seen in a comic paper a picture called "The Annual Ball of the Mushrooms." Psycho-analysis threw no light on the name "Gillis" nor on the blurred name.

Case VII. Observer L. Had a bad toothache, and though very sleepy and worn out could not sink into a sound slumber because of the pain. For several hours I lay in a state of semiconsciousness, tossing from side to side in a drowsy effort to find a comfortable position. All day I had been very intently working on a coat which I was making, and my tossings back and forth were all in terms of the seams on the coat, i.e., as I turned to the right the seam down the right side of the garment was inspected, then as that position gradually grew unbearable the seam began to wrinkle, to pucker, and to become quite unmanageable. Thereupon I decided to work awhile on the other seam, and turned to the left side and carefully basted and pressed the seam on the left side of the coat. But, though it behaved very satisfactorily for a time, it, too, soon began to wrinkle and the thread to snarl. In despair I attacked the seam on the right side again, that is, I turned over to my right side once more. This continued for an indefinite time. I was in despair. I feared the garment would be quite ruined. All through these hours I was conscious of the slight flapping of the window blind and twice I replied quite sensibly to the questions of my companion, and noted the striking of the hours on a clock in another apartment. But the illusion that I was wrestling with the seams of a refractory garment was not dispelled till I fell asleep at daylight.

Case VIII. Conversations during the drowsy state.

(*a*) L— Let's hurry and get there by ten o'clock.

H— That's easy. I could get there by a nickel to ten. (It was then 9.50.)

(*b*) H— (As L rises from the sofa where she has been resting and leaves the room.) So you want some water, huh?

L— (Entering again.) What did you ask about a drink?

H— Nothing.

L— But you asked me something about water.

H— (Drowsily.) It wasn't an asker, it was just a sayer.

(*c*) H is said to behave when drowsy much like a child or like a half-intoxicated man,—thus: he approaches an old pillow spotted with ink blots and asserts in a child-like way quite without provocation or connection,—"Red ink! black ink!" pointing to the spots meanwhile.

(*d*) L— Asks question to which H replies, quite without relevance, "I don't think you could see the manuscript."

(*e*) L— "How curious the moon looks behind the clouds!"

H— "Yes, just like a thin place in the sky."

Case IX. The writer has frequently recorded fantastic experiments and conclusions developed either alone or during discussions, late at night. At the time of their conception all of these plans and insights seemed highly rational, strikingly original and wonderfully significant, and the observer has usually marvelled that nobody had ever seen the thing so clearly before. He has frequently gone ahead after the midnight hours and prepared the material for one of the revolutionary experiments or demonstrations just conceived. But when the plan or conclusion has been gone over on the following morning the most striking thing about it has been its splendor as a work of unbridled imagination, but its absurdity as a scientific achievement. The argument is found to abound with fallacies or the experimental procedure with sources of error that were lightly bridged over the night before. The experience is no doubt a very common one. It seems much like the nocturnal aeronautic inspection of a line of march which must be gone over on foot when daylight comes.

Case X. The reason for citing the two following literary references will be seen later. They are typical drowsiness figures.

(*a*) This passage from Stevenson's letters to Henry James (Stevenson, *Letters*, p. 435) must have been written late at night and in a state of drowsiness. In fact Stevenson says earlier in the letter "my wife being at a concert and a story being done," indicating a late hour, and (especially in Stevenson's case) fatigue. Speaking of the "Henry James chair" the writer of the letter says, "It has been consecrated to guests by your approval and now stands at my elbow gaping. We have a new room, too, to introduce to you—our last baby, the drawing room; it never cries and has cut its teeth. Likewise there is a cat now."

(*b*) De Balzac, who wrote the following passage must have been a night worker,—"He saw his teeth departing one by one like brilliantly dressed ladies from a ball room."

The experiences here recorded can hardly be classed as dream states though it is true that only a little elaboration would be needed to make them develop into such states. They all occurred during waking moments, and frequently (see Cases 2, 5, 7) there is clear evidence that the observer is actively engaged in some waking employment or lively thought process or is conscious of external events. Yet most of them are hallucinatory in character.

EXERCISE

1. What are the chief points of similarity and of difference between the dreams of drowsiness and those of sleep?

6. THE SOURCES OF ORIGINAL THOUGHT[1]

BY EDWARD S. ROBINSON

Problems give rise to new ways of thinking.—Reasoning is an attempt to construct in thought the solution of some problem. The goal we wish to attain is in this case recognized, and the part played by imagination consists largely in foreseeing how well some mode of action, which is merely thought of, will further the attainment of that goal. This is, above all, a business-like procedure.

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[1] Adapted by permission from *Practical Psychology*, pp. 299–316. New York: Macmillan Co. Copyrighted, 1927.

There are other conditions under which the presence of a problem gives rise to imagination, even where there is no hope of finding a mode of action or thought which will furnish a genuine solution. All of us engage in day-dreaming, and it is a striking fact that these day-dreams are the results of problems that we face. These problems are, as a rule, the outcome of unfulfilled longings. The boy who desires athletic distinction, but who can never hope to realize that form of glory because of insurmountable physical limitations, will construct day-dreams in which athletic achievements are attained. He does not necessarily entertain these ideas as possible ways out of his difficulty, as possible methods of attaining the longed-for goal. They are rather enjoyed for their own sake. The ideas are not, as in reasoning, plans for action or for further thinking, but they are substitutes for the genuine.

New ways of thinking may be imparted to us by others.—New and skillful combinations of movement may be set up as the result of a laborious struggle with some problem. But often the construction of the new combination is made prompt and easy by virtue of the instruction or guidance which we receive from others. Instruction or guidance may similarly facilitate the formation of new ways of *thinking*.

The anticipation of a journey into countries never visited before consists in imagining many things about the places to be visited, methods of travel, and the like. Now there is little basis in my own personal experience for imaginings valid enough to guide my preparation for the journey. But I can talk to others who have made this journey, I can read books about traveling in foreign lands, and out of the ideas which are thus imparted I can construct fairly adequate notions of what lies before me. Because of what two friends have said, I anticipate very cold weather at sea, and, acting upon that idea, I shall take with me a heavy coat. Because of what another friend has told me, I think of the Atlantic next December as stormy and rough. Acting upon that idea, I shall try to book my return passage on as large and as steady a ship as possible. Somewhere in a book I have read that the heavy snows render certain Alpine places inaccessible by the middle of October. Knowing when I shall be in Switzerland, I can even now imagine something of the things I shall see and something of the things I shall be unable to see while there. Thus is my imagination made more accurate and useful by the guidance I am able to get from others.

The less practical imaginings in which one engages—the imaginings of the day-dream type—may also receive the benefit of considerable guidance. The clerk who lives a humdrum life may indulge in plays, motion pictures, and printed stories. These set up in him the most elaborate imaginings with scarcely any effort on his part.

The plays we see and the stories we read do more than simply furnish ready-made day-dreams. They furnish us with materials out of which new day-dreams can be fabricated. Perhaps the bored clerk imagines himself a prospector for gold in a rough section of Alaska. Perhaps he is attacked by three ruffians whom he bests single-handed. Perhaps he finally strikes it rich and returns to civilization to live out his remaining days amid the luxuries his gold can buy. Here is a revision and reconstruction of a motion-picture story made in the interests of the peculiar needs of a particular individual.

The work of fiction has still another frequent result. It creates unfulfillable desires which become the motives of our day-dreams. The clerk might possibly have been just as bored with his present occupation and quiet mode of living if he had never seen a motion picture and never read a frontier story. But having indulged in these dissipations, he began to see definite, if actually unattainable, alternative ways of living. In other words, the very desire for a life of brave adventure, for which his day-dreaming is a substitute, arose out of ready-made day-dreams furnished by play and story.

Originality is aided by broad experience.—It is sometimes assumed that originality of imagination has little or nothing to do with the extent of one's knowledge. Occasionally it does happen that a notion of considerable originality is produced by a person of relatively slight experience. The college wit contributes jokes as bright and original as those of the experienced, professional humorist. The young poet sometimes writes a short poem of unquestioned brilliance. William Cullen Bryant was only eighteen years of age when he wrote "Thanatopsis." The inventor of a clever and useful machine may be hopelessly ignorant of the science of mechanical engineering. Nevertheless, the man of sustained and consistent originality must have had wide experience. Milton and Shakespeare had great stores of information upon which to draw. and Newton is said to have had at his immediate command practically all of the scientific knowledge of his time.

It is not difficult to see why there is such a close relationship between originality and knowledge. Imagination consists in setting ideas into new combinations. The first requirement for such a process is the possession of the ideas. One cannot utilize in imagination ideas that he does not possess. A person of very limited experience may, as we have seen, make use of his few ideas in a brilliantly original manner, but his imagination is definitely limited by the scarcity of information at his command. Where experience is limited, original thought is likely to be original only to the thinker himself. A new employee in a shop or factory has been known to make an original suggestion worth thousands of dollars to his employers. Such fortunate occurrences stand out as exceptions, however, and the author of such a suggestion is not likely to continue to originate profitable schemes applicable to a business unless he straightway begins adding to his store of ideas about that business.

Original combinations of ideas are aided by unusual combinations of experience.—The newcomer in a business house ordinarily does not have revolutionary ideas about the conduct of affairs, and when he does, they are likely to be impracticable. Still, the newcomer does advance a valid and novel scheme once in a while, and there is some reason to believe that this even is not always pure accident. His previous experience may have been of a sort uncommon for a man in that particular business, and the ideas to which it gave rise may be just the ones to combine advantageously even with the first ideas he acquires about that business.

A thorough mastery of two or more different and yet associated bodies of knowledge is as good a basis as can be obtained for original thinking. Such thinking is especially likely to be done by a banker who has a knowledge of farming or of building trades, by a physiologist well grounded in physics, by a novelist who is acquainted with the ways of living in some other place or historical era, by the specialist in mental diseases who also knows much about normal mental processes.

Original thinking may become a habit.—There are individuals who make a habit of mulling over their ideas, and getting them into new relations and combinations. In such individuals original thinking comes as natural and as easy as original thinking ever is. When they read a book, they do not stop there. They recall from time to time ideas that they have gathered from it. They compare in a reflective manner the opinions of one author with those of another. All this tends toward the production of new ideational combinations. Ideas obtained from first-hand experience as well as those obtained from books are treated in this way.

The creative thinker does not accept things at their face value.—Perhaps the most striking characteristic of the creative thinker is his unwillingness to accept the world of facts or ideas at its face value. He looks behind the facts for meanings, relationships, and possibilities which have hitherto escaped notice. He is not content to accept ideas just as they are imparted to him. He must evaluate them anew. He must determine just how well, after all, they do correspond to the world of facts. Or, if those ideas be of a fanciful sort, he must redetermine their artistic value. Where changes seem to him desirable, he makes them. Such a thinker dares entertain the notion of sailing west to India instead of east. Such a thinker looks for a relationship between lightning and electricity.

Professor Calkins shows the contrast between original and less original thought by setting side by side two well-known poems, Shelley's "Sensitive Plant" and Cowper's "Winter Garden."

> Who loves a garden, (is Cowper's prosaic beginning)
> . . . . Loves a greenhouse too.
> Unconscious of a less propitious clime,
> There blooms exotic beauty, warm and snug,
> While the winds whistle and the snows descend.
> The spiry myrtle with unwith'ring leaf
> Shines there and flourishes. The golden boast
> Of Portugal and western India there,
> The ruddier orange, and the paler lime,
> Peep through their polish'd foliage at the storm,
> And seem to smile at what they need not fear.
> Th' amomum there with intermingling flow'rs
> And cherries hangs her twigs. Geranium boasts
> Her crimson honors, and the spangled beau,
> Ficoides, glitters bright the winter long.
> All plants of ev'ry leaf, that can endure
> The winter's frown, if screen'd from his shrewd bite,
> Live there, and prosper. Those Ausonia claims,
> Levantine regions these; th' Azores send
> Their jessamine, her jessamine remote
> Caffraia; . . .

No one (Professor Calkins goes on to say) can read this list of flowers without the conviction that Cowper is either 'reproducing' the rows of plants as he saw them one after another in a greenhouse, or else that he is framing an image after the most mechanical fashion. There is certainly little that is individual in the entire description, and the images, regarded from the standpoint of association, are connected as undifferentiated totals, instead of being broken up into more remotely suggestive elements.

Shelley also enumerates the flowers of his garden, but in a very different manner.

The snowdrop, and then the violet,
Arose from the ground with warm rain wet,
And their breath was mixed with fresh odor, sent
From the turf, like the voice and the instrument.

Then the pied wind-flowers and the tulip tall,
And narcissi, the fairest among them all,
Who gaze on their eyes in the stream's recess,
Till they die of their own dear loveliness;

And the Naiad-like lily of the vale,
Whom youth makes so fair and passion so pale,
That the light of its tremulous bells is seen
Through their pavillions of tender green.

We have here (says Professor Calkins, commenting upon this poem of Shelley's) neither a reproduction nor a mechanical composition, but an organically related, individual experience. Almost every one of these exquisite images is connected in partial association with that which has preceded it: the mingling of earth-fragrance with the odors of the flowers suggests the interpenetration of voice and instrument; the early fading of the narcissi, mirrored in the stream, rouses the fancy that they 'die of their own dear loveliness'; the tall lily leaves suggest sheltering pavilions. And, side by side with Cowper's superficial and fanciful comparison of Ficoides with the spangled beau, Shelley's images of music, of beauty, and of passion fairly throb with life and meaning.[1]

Creative thought is relatively rare.—The easy road is that of accepting things as they are or as people say they are. Even when one has need of a day-dream to satisfy in part some unfulfilled desire, it is easier to utilize a conventional day-dream which one has read in a book than to construct a story suited to one's own special needs.

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[1] *An Introduction to Psychology*, pp. 206–7. New York: Macmillan Co., 1908.

One may start off in business, in science, or in art full of the intellectual energy that gives rise to novelty, but, unless one be on his guard, he is likely to rely more and more upon ideas as he or others have worked them out in the past. Too much sameness of scene or occupation is a prevalent cause for the destruction of originality in those who once challenged almost every fact and idea confronting them. We have remarked that unusual combinations of experiences are pre-eminently the stimulators of thought that is original. And it is also true that there is no surer way to fall into stereotyped and conventional modes of thought than by avoiding novel experiences. A certain amount of travel, of intercourse with new acquaintances, of reading on new subjects, and, above all, of reflection upon these added experiences will keep one out of a narrow intellectual rut.

Upon whatever we turn our attention, there are customary ways of thinking about that subject. So strong are some of these customary ways of thinking, and so backed are they by the prestige of their very antiquity, that only the exceptional and hardy intellect can persist in an original opinion, even if its truth should, so far as the logic of the matter is concerned, be obvious to all. The evidence was greatly in favor of a spherical earth long before men would entertain the idea seriously. They had thought the world was flat for centuries, and that inaccurate conception kept a better one from even entering their minds. A poem of Sam Foss's which Professor Ross has quoted[1] is a happy illustration of our point.

THE CALF PATH

One day, through a primeval wood,
A calf walked home as good calves should,
And left a trail all bent askew,
A crooked trail, as all calves do.
Since then two hundred years have fled,
And I infer the calf is dead,
But still he left behind his trail,
And thereby hands my moral tale.

The trail was taken up next day
By a lone dog that passed that way;
And then a wise bell-wether sheep
Pursued the trail o'er dale and steep,
And led his flock behind him, too,
As good bell-wethers always do.

[1] *Social Psychology*, p. 257. New York: Macmillan Co., 1908.

And from that day, o'er hill and glade,
Through those old woods a path was made,
And many men wound in and out,
And bent and turned and crooked about,
And uttered words of righteous wrath,
Because 'twas such a crooked path.
But still they followed—do not laugh—
The first migrations of that calf,
And through this winding woodway stalked
Because he wobbled when he walked.

. . . .

And men in two centuries and a half
Trod in the footsteps of that calf,
For men are prone to go it blind,
Along the calf-ways of the mind,
And work away from sun to sun,
To do as other men have done.

Originality does not guarantee the truth or value of thought.—The incoherent nonsense of an insane patient may be original enough, yet the fact of originality does not, in itself, insure the truth or value of his thinking. Consider the thought processes of the author of the following speech:

> Well, Doctor, I tell you I suffered terribly this winter, also on post of duty. I do not know anything about it; there is an illustration there. I cannot blame the band while at school about their music. That thermometer there is to tell whether you live or die, and it becomes such a dangerous position that the enemies approaching at this post of duty, I cannot do it with the light. That man escaped. He is living at his house in Birmington, N.Y., where I know not. I know that his name is Irish. They will not take him to his rightful home in the condition of such by which he has no means of support by attending bar. I was kidnapped upon the ocean, and taking en route to this place I know not. Well, as I was going to tell you, I am the enemy himself. These people here cannot perform an operation. They do not know what they are. Well do you know me! I am the king of Ireland and also of all countries in existence. I was the fellow that killed the queen. I do not know who she was. I got the picture of him. His last name was Duff. I can not get into communication with him.[1]

Such combinations of ideas are original enough. They certainly do not represent ideas or objects or events as they have occurred upon some former occasion. The results of past experiences must have combined and produced this novel and original flow of thought. But with all its originality, such thinking does not uncover hidden truth nor does it rise to new artistic heights. It corresponds neither with a world of actual fact nor with one of legitimate fancy.

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[1] Quoted by White, in *Outlines of Psychiatry*, p. 146.

Originality, in other words, cannot be evaluated in and for itself. Originality is meritorious only when it furthers the worthy enterprises of life. In this regard it is only like other facts of mental life. There was recently described in one of the psychological journals a feeble-minded boy who had a remarkable memory. Give him a date, such as March 8, 1908, and he can immediately give you the day of the week on which that date occurred. Within a range of something like twenty years his memory for days and dates is almost perfect. And yet no one would seriously praise his memory. It is complete enough and accurate enough, but it is not particularly useful for the more important purposes of life. Some people have held to the superstition that habits, as such, are undesirable, and that one should keep as free from them as possible. But we know now that habits cannot be evaluated simply as habits. Their consequences must be taken into account. The habit of overeating is bad, not because it is a habit, but because of its results. The habit of being friendly or cheerful is good, not because it is a habit, but because of its results. So it is with originality. A cleverly planned crime may be original, but it is not its originality which makes it bad. It is bad because it is a crime. A story may be very original, but unless it fits in with certain artistic needs and standards, it will be judged good.

When old ways of thinking become inadequate, imagination offers new ways of thinking, some of which may fill one's needs and some of which may be useless. Without imagination there would be no new ways of thinking, but unless there were an evaluation of the various manifestations of imagination and a selection from among them of those corresponding to actual facts and needs, imagination would lead to disaster about as often as to advantage.

Originality should not be cultivated for its own sake.—The greatest thinkers have not been those who cast aside most ruthlessly all established modes of thought. Great thinkers are rather those who display imagination in some critical situation where others have failed to display it. Newton, as we have said, mastered much of the established scientific knowledge of his time, and most of it he accepted. But here and there he felt that there was a weak link or a gap in existing knowledge, and that is where his imaginings began. He imagined that the falling apple and the movements of the heavenly bodies might be operating according to a single law of gravitation, a supposition he was later able to prove. Now it was not that Newton imagined so freely or so extensively but rather that he imagined *so well* in regard to such a crucial scientific problem that makes us revere his memory. Shakespeare did not hesitate to borrow complete plots from other writers. He knew where he could get a good plot whenever he wanted one, and to those sources he went. His own imaginative efforts were saved for the concoction of those details of dialog and action that make all the difference between life and some dead chronicle.

A struggle for originality which is carried on always and everywhere, whether or not there is a need for it, is an unfortunate affair. It is such a waste of energy! Quite frequently a kind of false pride makes a man unwilling to accept any mode of thought that is not a product of his own imagining. He does not care greatly how or to what end he modifies the thoughts of others, if only he modifies them. We have all met individuals with characteristics similar to those which William James, in his "Letters," attributed to a certain professor. "——— has the most prodigious faculty of appropriating and preserving knowledge, and as for opinions, he takes *au grand serieux* his duties there. He says of each possible subject, 'Here I must have an opinion. Let's see! What shall it be? How many possible opinions are there? three? four? Yes! just four! Shall I take one of these? It will seem more original to take a higher position, a sort of Vermittelungsansicht[1] between them all.' That I will do, etc., etc."

Inspiration and deliberate creation compared.—Every one is familiar with the fact that new combinations of ideas sometimes occur spontaneously and with a minimum of effort and at other times only as the result of a long and deliberate process of reflection. There have been very effective thinkers who have relied to an astonishing degree upon the immediate and spontaneous type of production. This is said to have been true of Poincaré, the eminent French mathematician. He often began writing a scientific article without any conclusion in mind, in the hope that appropriate ideas would come to him as he wrote. If the ideas failed to take form easily he would abandon the paper temporarily and count upon having better fortune when he resumed work upon it.

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[1] A mediatory attitude (a view).

The creative activities of the composer, Mozart, also took this spontaneous, inspirational form. He says:

> When I am feeling well and in good humor, perhaps when I am traveling by carriage or taking a walk after a good dinner, or at night when I cannot sleep, my thoughts come in swarms and with marvelous ease. Whence and how do they come? I do not know. I have no share in it. Those that please me I hold in mind and I hum them, at least so others have told me. Once I catch my air, another comes soon to join the first according to the requirements of the whole composition counterpoint, the play of the various instruments, etc., etc., and all these morsels combine to form the whole.[1]

So spontaneously did his poems come to him that William Blake, an English writer and painter, believed that they must have a supernatural origin. While we ourselves should hardly fall back upon such an explanation, his own statement is worth considering, because it gives a vivid picture of an extreme case of the so called inspirational form of imagination. "I have written this poem (*Jerusalem*) from immediate dictation. . . . . without premeditation and even against my will. . . . . I dare not pretend to be other than the secretary. The authors are in eternity." Poetry and art, he says in another place, are least creations of the poet or artist, but of powers beyond control.

> A poem is not written by the man who says: I will sit down and write a poem; but rather by the man who, captured by rather than capturing an impulse, hears a tune which he does not recognize, or sees a sight which he does not remember in some "close corner" of his brain, and exerts the only energy at his disposal in recording it faithfully in the medium of his particular art.[2]

It is a popular belief that this inspirational type of production, during which the thinker has the feeling that his imagination is running freely and beyond control, is a necessary characteristic of the great man, especially if he be working in some field of art. However, substantial evidence for this belief is lacking. Exquisite works of art may be produced by imaginative processes that are of the most deliberate and voluntary sort. There have doubtless been many deliberate workers in the various fields of art, but Émile Zola is, perhaps, the most often cited to illustrate this point So rational and deliberate were his acts of creation that he likened himself to a scientist conducting an experiment. He observed in great detail the lives and surroundings of the type of people about whom he wished to write. To do this he might actually go to live among them. He tells us:

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[1] Quoted by F. C. Prescott, *The Poetic Mind*, p. 42. New York: Macmillan Co., 1922.

[2] Arthur Symons, *William Blake*, pp. 14–15. New York: E. P. Dutton & Co., 1907.

> After spending two or three months in this study, I am master of this particular kind of life, I see it, I feel it, I live in it in imagination, and I am certain of being able to give my novel the special colour and perfume of that class of people. Besides, by living some time as I have done amongst this class of people, I have made the acquaintance of individuals belonging to it, I have heard real facts related, I know what occurs there as a general rule, I have learned the language which they usually talk, I have in my head a quantity of types, of scenes, of fragments of dialogue, of episodes, of occurrences, which form a confused story made up of a thousand unconnected fragments. Then there remains to be done what for me is the most difficult task of all, to attach to a single thread, as best I am able, all these reminiscences and scattered impressions. It is almost always a lengthy task. But I set to work upon it phlegmatically, and instead of using my imagination I use my reasoning faculties. I argue to myself, I write my monologues word for word, just as they occur to me, so that, read by another, they would appear strange. So-and-so does this or that. What would be the natural result of such-and-such an act?[1]

To most of us the deliberative, reflective, painstaking sort of imaginative creation seems natural enough. It is the non-deliberative, spontaneous, inspirational sort of creation that calls for explanation. And it is creation of this latter variety that is most likely to be explained in terms of some mysterious and supernatural force making itself felt upon the mind of the thinker. But there are certain important facts which indicate that inspiration is no more supernatural than any other form of imagining. In the first place, those who are unskilled in the ways of art or literature seldom come forth suddenly with an epoch-making creation. Inspiration occurs most frequently among those who are in the habit of getting inspired; that is to say, among those who have worked and meditated in the field of poetry, painting, or some other art. If inspiration were an external force affecting the individual, we should hardly expect it to be so selective. In the second place, the subject-matter of inspired ideas is always closely related in some way to the life, surroundings, and thought of the artist. Even such a spontaneous producer as Blake spent much time studying the subjects which his poetry and painting involved. He attended the picture galleries and discussed their contents in detail with his friends. Before painting on the subjects of Dante's work, he undertook an

[1] R. H. Sherard, *Émile Zola*, pp. 135–36. London: Chatto & Windus, 1893.

extensive study of the Italian Poet. In the third place, the products of inspiration, as a rule, have to be subjected to elaborate criticism and revision. All of these facts make the spontaneous type of production seem very much a matter of this world of natural events.

Why imagination sometimes seems so spontaneous.—While we are justified in putting aside as false any supernatural explanation of inspiration, the problem still remains of establishing the reason why imaginative creation does, at times, proceed so spontaneously and smoothly that it seems directed by external forces. Our ideas are associated with perceptions and other ideas, and when an idea is aroused, it is aroused by some experience which has been associated with it. Now there is a clear, logical connection between most ideas and the experiences which have become associated with them. Under such circumstances we are not baffled at the occurrence of an idea. If, for example, a warm spring breeze against my cheek arouses in me ideas of the coming summer and if these, in turn, arouse ideas of what I intend to do during the vacation days, I am not likely to feel that these ideas have been given me by some external agency. Such a succession of thoughts is what I have learned to expect of myself and therefore their occurrence seems perfectly natural. I should never think of explaining their rise as due to supernatural causes. But it is possible for any idea to become associated with any experience. This allows for associations where the logical connection is not so evident. Consider Shelley's lines about the snowdrop and the violet:

> And their breath was mixed with fresh odors, sent
> From the turf, like the voice and the instrument.

One in whom the odor of flowers and turf arouses ideas of interpenetrating voice and instrument might easily feel that this unusual association could not be explained in terms of some past experience he has had. Try as he may, it is not likely that he can find in his own history the specific origin of this association. Thereupon he will be tempted to explain it in terms of some outside agency. Yet it is certain that somewhere in his past experience there lies an explanation for this particular association. The difficulty is that his memory is not complete enough to reveal the complete history of his experiences with flowers and instruments.

There is another peculiarity of spontaneous creation besides the fact that it seems so detached from the ordinary ways of thinking and from any specific past experiences which the thinker has had. During a period of so-called inspiration, ideas may be aroused quickly, abundantly, and without any sense of effort. Very often the explanation for this facility of thought lies simply in the fact that the thinker has got himself into a physical and mental condition where stimuli, which might arouse irrelevant thoughts, and so disrupt the ready flow, are lacking. If one gets into the habit of thinking in a particular room and at a definite hour, his presence in that room at that hour may be enough to set up a ready flow of thought. Fixed habits of work have been frequent among great thinkers.

> Many writers feel the need of being in particular spots, of using peculiarly colored paper or ink before they can do well. Rousseau found composition difficult unless he was walking. Neander composed best lying on his stomach. Coleridge liked to compose best while walking over uneven ground. Sheridan composed at night with a profusion of lights about him. Lamartine had a studio of tropical plants. Dr. George Ebers imagines himself more at liberty to write with a board on his lap than at the desk. Vacano composed at all times, but the place he was in was important, and he could write best in the hubbub of peasant life near an old mill. Maurice Jokai must have fine pens and violet ink. These habits, however acquired, evidently have great power of distracting the attention if they are not satisfied, and so retard work.[1]

And, we might add, these habits may come to be so associated with creative thinking that they seem automatically to set the imagination free. We might cite one more illustration of a very modern variety. A certain English statesman is a public speaker of wide reputation. Set him on his feet before a great crowd, and his eloquence is sure and unhesitating. Not a long time ago, so it is said, this Englishman delivered his first radio address. He was taken alone into the sending-room, shown his position, and told to begin his speech. Not for years had words failed him, but here, in this strange setting, his voice seemed paralyzed. He lacked the associative cues to set him off, and he fought for his first words as does a man who has never been called inspired.

EXERCISES

1. Why is it that the possession of mere information will not, of itself, make a man an original thinker?
2. Why is it that the world has such a strong inclination to explain the imagination of the great man as due to a supernatural inspiration?
3. Is the value of a piece of literature affected if we are able to explain the imagination of its author in natural rather than in supernatural terms? Defend your answer.

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[1] Bergstrom, *American Journal of Psychology*, VI, 267.

CHAPTER XV

LANGUAGE

1. THE ORIGIN OF LANGUAGE

A[1]

BY EDWARD B. TYLOR

In studying the means of expression among men in stages of mental culture far below our own, one of our first needs is to clear our minds of the kind of superstitious veneration with which articulate speech has so commonly been treated, as though it were not merely the principal but the sole means of uttering thought. We must cease to measure the historical importance of emotional exclamations, of gesture-signs, and of picture-writing, by their comparative insignificance in modern civilized life, but must bring ourselves to associate the articulate words of the dictionary in one group with cries and gestures and pictures, as being all of them means of manifesting outwardly the inward workings of the mind. Such an admission, it must be observed, is far from being a mere detail of scientific classification. It has really a most important bearing on the problem of the Origin of Language. For as the reasons are mostly dark to us, why particular words are currently used to express particular ideas, language has come to be looked upon as a mystery, and either occult philosophical causes have been called in to explain its phenomena, or else the endowment of man with the faculties of thought and utterance has been deemed insufficient, and a special revelation has been demanded to put into his mouth the vocabulary of a particular language. In the debate which has been carried on for ages over this much-vexed problem, the saying in the *Kratylos* comes back to our minds again and again, where Sokrates describes the etymologists who release themselves from their difficulties as to the origin of words by saying that the first words were divinely made, and therefore right, just as the tragedians, when they are in perplexity, fly to their machinery and bring in the gods. Now I think that those who soberly contemplate the operation of cries, groans, laughs, and other emotional utterances, as to which some considerations have been here brought forward, will admit, that, at least, our present crude understanding of this kind of expression would lead us to class it among the natural actions of man's body and mind. Certainly, no one who understands anything of the gesture-language or of picture-writing would be justified in regarding either as due to occult causes, or to any supernatural interference with the course of man's intellectual development. Their cause evidently lies in natural operations of the human mind, not such as were effective in some long past condition of humanity and have since disappeared, but in processes existing amongst us, which we can understand and even practise for ourselves. When we study the pictures and gestures with which savages and the deaf-and-dumb express their minds, we can mostly see at a glance the direct relation between the outward sign and the inward thought which it makes manifest. We may see the idea of "sleep" shown in gesture by the head with shut eyes, leant heavily against the open hand; or the idea of "running" by the attitude of the runner, with chest forward, mouth half open, elbows and shoulders well back; or "candle" by the straight forefinger held up, and as it were blown out; or "salt" by the imitated act of sprinkling it with thumb and finger. The figures of the child's picture-book, the sleeper and the runner, the candle and the salt-cellar, show their purport by the same sort of evident relation between thought and sign. We so far understand the nature of these modes of utterance, that we are ready ourselves to express thought after thought by such means, so that those who see our signs shall perceive our meaning.

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[1] Taken from *Primitive Culture*, I, 232–35. New York: Henry Holt & Co., 1889

When, however, encouraged by our ready success in making out the nature and action ot these ruder methods, we turn to the higher art of speech, and ask how such and such words have come to express such and such thoughts, we find ourselves face to face with an immense problem, as yet but in small part solved. The success of investigation has indeed been enough to encourage us to push vigorously forward in the research, but the present explorations have not extended beyond corners and patches of an elsewhere unknown field. Still the results go far to warrant us in associating expression by gestures and pictures with articulate language as to principles of original formation, much as men associate them in actual life by using gesture and word at once. Of course, articulate speech, in its far more complex and elaborate development, has taken up devices to which the more simple and rude means of communication offer nothing comparable. Still, language, so far as its constitution is understood, seems to have been developed like writing or music, like hunting or fire-making, by the exercise of purely human faculties in purely human ways. This state of things by no means belongs exclusively to rudimentary philological operations, such as the choosing expressive sounds to name corresponding ideas by. In the higher departments of speech, where words already existing are turned to account to express new meanings and shade off new distinctions, we find these ends attained by contrivances ranging from extreme dexterity down to utter clumsiness. For a single instance, one great means of giving new meaning to old sound is metaphor, which transfers ideas from hearing to seeing, from touching to thinking, from the concrete of one kind to the abstract of another, and can thus make almost anything in the world help to describe or suggest anything else. What the German philosopher described as the relation of a cow to a comet, that both have tails, is enough and more than enough for the language-maker. It struck the Australians, when they saw a European book, that it opened and shut like a mussel-shell, and they began accordingly to call books "mussels" (*mūyūm*). The sight of the steam engine may suggest a whole group of such transitions in our own language; the steam passes along the "fifes" or "trumpets," that is, *pipes* or *tubes*, and enters by "folding-doors" or *valves*, to push a "pestle" or *piston* up and down in a "roller" or *cylinder*, while the light pours from the furnace in "staves" or "poles," that is, in *rays* or *beams*. The dictionaries are full of cases compared with which such as these are plain and straightforward. Indeed, the processes by which words have really come into existence may often enough remind us of the game of "What is my thought like?" When one knows the answer, it is easy enough, to see what *junketting* and cathedral *canons* have to do with reeds; Latin *juncus* "a reed," Low Latin *juncata*, "cheese made in a reed-basket," Italian *giuncata*, "cream cheese in a rush frail," French *joncade* and English *junket*, which are preparations of cream, and lastly *junketting* parties where such delicacies are eaten; Greek κάνη, "reed, *cane*," κανῶν, "measure, rule," thence *canonicus*, "a clerk under the ecclesiastical rule or canon." But who could guess the history of these words, who did not happen to know these intermediate links?

B[1]

BY OTTO JESPERSEN

One theory is that primitive words were imitative of sounds: man copied the barking of dogs and thereby obtained a natural word with the meaning of "dog" or "bark." To this theory, nicknamed the

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[1] Adapted from *Language, Its Nature, Development and Origin*, pp. 413–16. New York: Henry Holt & Co., 1922.

bow-wow theory, Renan objects that it seems rather absurd to set up this chronological sequence: first the lower animals are original enough to cry and roar; and then comes man, making a language for himself by imitating his inferiors. But surely man would imitate not only the cries of inferior animals, but also those of his fellow-men, and the salient point of the theory is this: sounds which in one creature were produced without any meaning, but which were characteristic of that creature, could by man be used to designate the creature itself (or the movement or action productive of the sound). In this way an originally unmeaning sound could in the mouth of an imitator and in the mind of someone hearing that imitation acquire a real meaning. I have tried to show how from the rudest and most direct imitations of this kind we may arrive through many gradations at some of the subtlest effects of human speech, and how imitation, in the widest sense we can give to this word—a wider sense than most advocates of the theory seem able to imagine—is so far from belonging exclusively to a primitive age that it is not extinct even yet. There is not much of value in Max Müller's remark that "The onomatopoeic theory goes very smoothly as long as it deals with cackling hens and quacking ducks; but round that poultry-yard there is a high wall, and we soon find that it is behind that wall that language really begins," or in his other remark that "words of this kind (*cuckoo*) are, like artificial flowers, without a root. They are sterile, and unfit to express anything beyond the one object which they imitate." But *cuckoo* may become *cuckold* (Fr. *cocu*), and from *cock* are derived the names Müller himself mentions, Fr. *coquet*, *coquetterie*, *cocart*, *cocarde*, *coquelicot*. . . . . Echoic words may be just as fertile as any other part of the vocabulary.

Another theory is the interjectional, nicknamed the *pooh-pooh*, theory: language is derived from instinctive ejaculations called forth by pain or other intense sensations or feelings. The adherents of this theory generally take these interjections for granted, without asking about the way in which they have come into existence. Darwin, however, in *The Expression of the Emotions*, gives purely physiological reasons for some interjections, as when the feeling of contempt or disgust is accompanied by a tendency "to blow out of the mouth or nostrils, and this produces sounds like *pooh* or *pish*." Again, "when anyone is startled or suddenly astonished, there is an instantaneous tendency, likewise from an intelligible cause, namely, to be ready for prolonged exertion, to open the mouth widely, so as to draw deep and rapid inspiration. When the next full expiration follows, the mouth is slightly closed, and the lips, from causes hereafter to be discussed, are somewhat protruded; and this form of the mouth, if the voice be at all exerted, produces . . . . the sound of the vowel *o*. Certainly a deep sound of a prolonged *Oh!* may be heard from a whole crowd of people immediately after witnessing any astonishing spectacle. If, together with surprise, pain be felt, there is a tendency to contract all the muscles of the body, including those of the face, and the lips will then be drawn back; and this will perhaps account for the sound becoming higher and assuming the character of *Ah!* or *Ach!*"

To the ordinary interjectional theory it may be objected that the usual interjections are abrupt expressions for sudden sensations and emotions; they are therefore isolated in relation to the speech material used in the rest of the language. "Between interjection and word there is a chasm wide enough to allow us to say that the interjection is the negation of language, for interjections are employed only when one either cannot or will not speak." This "chasm" is also shown phonetically by the fact that the most spontaneous interjections often contain sounds which are not used in language proper, voiceless vowels, inspiratory sounds, clicks, etc., whence the impossibility properly to represent them by means of our ordinary alphabet: the spellings *pooh*, *pish*, *whew*, *tut* are very poor renderings indeed of the natural sounds. On the other hand, many interjections are now more or less conventionalized and are learnt like any other words, consequently with a different form in different languages: in pain a German and a Seelander will exclaim *au*, a Jutlander *aus*, a Frenchman *ahi* and an Englishman *oh*, or perhaps *ow*. Kipling writes in one of his stories: "That man is no Afghan, for they weep 'Ai! Ai!' Nor is he of Hindustan, for they weep 'Oh! Ho!' He weeps after the fashion of the white men, who say, 'Ow! Ow!'"

A closely related theory is the nativistic, nicknamed the *ding-dong*, theory, according to which there is a mystic harmony between sound and sense: "There is a law which runs through nearly the whole of nature, that everything which is struck rings. Each substance has its peculiar ring." Language is the result of an instinct, a "faculty peculiar to man in his primitive state, by which every impression from without received its vocal expression from within"—a faculty which "became extinct when its object was fulfilled." This theory, which Max Müller propounded and afterwards wisely abandoned, is mentioned here for the curiosity of the matter only.

Noiré started a fourth theory, nicknamed the *yo-he-ho:* under any strong muscular effort it is a relief to the system to let breath come out strongly and repeatedly, and by that process to let the vocal chords vibrate in different ways; when primitive acts were performed in common, they would, therefore, naturally be accompanied with some sounds which would come to be associated with the idea of the act performed and stand as a name for it; the first words would accordingly mean something like "heave" or "haul."

Now, these theories, here imperfectly reproduced each in a few lines, are mutually antagonistic: thus Noiré thinks it possible to explain the origin of speech without sound imitation. And yet what should prevent our combining these several theories and using them concurrently? It would seem to matter very little whether the first word uttered by man was *bow-bow* or *pooh-pooh*, for the fact remains that he said both one and the other. Each of the three chief theories enables one to explain *parts of language*, but still only parts, and not even the most important parts—the main body of language seems hardly to be touched by any of them. Again, with the exception of Noiré's theory, they are too individualistic and take too little account of language as a means of human intercourse. Moreover, they all tacitly assume that up to the creation of language man had remained mute or silent; but this is most improbable from a physiological point of view.

EXERCISE

1. Give several words illustrating the "bow-bow" theory and several illustrating the "pooh-pooh" theory.

2. GESTURE[1]

BY EDWARD B. TYLOR

There are various ways in which men can communicate with one another. They can make *gestures*, *utter cries*, *speak words*, *draw pictures*, *write characters* or *letters*. These are signs of various sorts, and to understand how they do their work, let us begin by looking at such signs as are most simple and natural.

When for any reason people cannot talk together by word of mouth, they take to conversing by gestures, in what is called dumb show or pantomime. Every reader of this has been able from childhood to carry on conversation in this way, more or less cleverly. Imagine a simple case. A boy opens a parlour door; his brother sitting there beckons to him to be quiet for his father is asleep; the boy now intimates by signs that he has come for the key of the box, to which his brother answers by other signs that it is in the pocket of his coat hanging in the hall, concluding with a significant gesture to be off and shut the door quietly after him. This is the *gesture-language* as we all know how to use it. But to see what a full and exact means of communication it may be worked up to, it should be watched in use among the deaf-and-dumb, who have to depend so much upon it. To give an idea how far gestures can be made to do the work of spoken words, the signs may be described in which a deaf-and-dumb man once told a child's story in presence of the writer of this account. He began by moving his hand, palm down, about a yard from the ground, as we do to show the height of a child—this meant that it was a child he was thinking of. Then he tied an imaginary pair of bonnet-strings under his chin (his usual sign for female), to make it understood that the child was a little girl. The child's mother was then brought on the scene in a similar way. She beckons to the child and gives her twopence, these being indicated by pretending to drop two coins from one hand into the other; if there had been any doubt as to whether they were copper or silver coins, this would have been settled by pointing to something brown, or even by one's contemptuous way of handling coppers which at once distinguishes them from silver. The mother also gives the child a jar, shown by sketching its shape with the forefingers in the air, and going through the act of handing it over. Then by imitating the unmistakable kind of twist with which one turns a treacle-spoon, it is made known that it is treacle the child has to buy. Next a wave of the hand shows the child being sent off on her errand, the usual sign of walking being added, which is made by two fingers walking on the table. The turning of an imaginary door-handle now takes us into the shop, where the counter is shown by passing the flat hands as it were over it. Behind this counter a figure is pointed out; he is shown to be a man by the usual sign of putting one's hand to one's chin and drawing it down where the beard is or would be; then the sign of tying an apron around one's waist adds the information that the man is a shopman. To him the child gives her jar, dropping the money into his hand, and moving her forefinger as if taking up treacle, to show what she wants. Then we see the jar put into an imaginary pair of scales which go up and down; the great treacle jar is brought from the shelf and the little one filled, with the proper twist to take up the last trickling thread; the grocer puts the two coins in the till, and the little girl sets off with the jar. The deaf-and-dumb story-teller went on to show in pantomime how the child, looking down at the jar, saw a drop of treacle on the rim, wiped it off with her finger and put the finger in her mouth, how she was tempted to take more, how her mother found her out by the spot of treacle on her pinafore, and so forth.

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[1] Taken from *Anthropology, an Introduction to the Study of Man and Civilization* pp. 114–17. New York: D. Appleton & Co., 1916.

The student anxious to master the principles of language will find this gesture-talk so instructive, that it will be well to explain its working more closely. The signs used are of two kinds. In the first kind things actually present are shown. Thus if the deaf-mute wants to mention "hand" or "shoe," he touches his own hand or shoe. Where a speaking man would say "I," "thou," "he," the deaf-mute simply points to himself and the other persons. To express "red" or "blue" he touches the inside of his own lip or points to the sky. In the second kind of signs ideas are conveyed by imitation. Thus pretending to drink may mean "water," or "to drink," or "thirsty." Laying the cheek on the hand expresses "sleep" or "bedtime." A significant jerk of the whip-hand suggests either "whip" or "coachman," or "to drive," as the case may be. A "lucifer" is indicated by pretending to strike a match, and "candle" by the act of holding up the forefinger like a candle and pretending to blow it out. Also in the gesture-language the symptoms of the temper one is in may be imitated, and so become signs of the same temper in others. Thus the act of shivering becomes an expressive sign for "cold"; smiles show "joy," "approval," "goodness," while frowns show "anger," "disapproval," "badness." It might seem that such various meanings to one sign would be confusing, but there is a way of correcting this, for when a single sign does not make the meaning clear, others are brought in to supplement it. Thus if one wants to express "a pen," it may not be sufficient to pretend to write with one, as that might be intended for "writing" or "letter," but if one then pretends to wipe and hold up a pen, this will make it plain that the pen itself is meant.

The signs hitherto described are self-expressive, that is, their meaning is evident on the face of them, or at any rate may be made out by a stranger who watches their use. Of such self-expressive or natural signs, the gesture-language mostly consists. But where deaf-mutes live together, there come into use among them signs which a stranger can hardly make out until it is explained to him how they arose. They will, for instance, mention one another by nickname-signs, as when a boy may be referred to by the sign of sewing, which on inquiry proves to have been given him because his father was a tailor. Such signs may be very far-fetched; for instance, at the Berlin Deaf-and-dumb Institution, the sign of chopping off a head means a Frenchman, and on inquiry it appears that the children, struck by reading of the death of Louis XVI in the history-book, had fixed on this as a sign-name for the whole nation. But to any new child who learnt these signs without knowing why they were chosen, they would seem artificial.

EXERCISE

1. Enumerate circumstances under which vocal expression is likely to be accompanied by gesture.

3. SPEECH

A[1]

BY WILHELM WUNDT

We obtain no information in regard to the *general development of speech* from the individual development of the child, because in the case of the child the larger part of the process depends on those about him rather than on the child himself. Yet, the fact that the child learns to speak at all, shows that he has psychical and physical traits favorable to the reception of language when it is communicated. In fact, it may be assumed that these traits would, even if there were no communications from without, lead to the development of some kind of expressive movements accompanied by sounds, which sounds would form an incomplete language. This supposition is justified by the observation of the deaf and dumb, especially deaf and dumb children who have grown up without any systematic education. In spite of this lack of education, an energetic mental intercourse may take place between them. In such cases, however, since the deaf and dumb can perceive only *visual* signs, the intercourse must depend on the development of a natural *gesture language* made up of a combination of significant expressive movements. Feelings are in general expressed by mimetic movements, ideas by pantomimetic movements, either by pointing at the object with the finger or by drawing some kind of picture of the idea in the air, that is, by means of indicative or representative gestures. There may even be a combination of such signs with each other, thus leading to a kind of sentence structure by means of which wishes and questions are expressed, things are described, and occurrences narrated. This natural gesture language can never go any further, however, than the communication of concrete sensible ideas and their interconnections. Signs for abstract concepts are entirely wanting.

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[1] Adapted by permission from *Outlines of Psychology* (3d ed.), pp. 339–43 (Translated by Charles H. Judd.) Leipzig: Alfred Kröner Verlag, 1907.

The primitive development of *articulate* language can hardly be thought of except after the analogy of the rise of this natural gesture language. The only difference is that in this case the ability to hear, results in the addition of a third form of movements to the mimetic and pantomimetic movements. This third form consists in the articulatory movements, and since such articulatory movements are much more easily perceived, and capable of incomparably more various modifications, it must of necessity follow that they soon exceed the others in importance. But just as gestures owe their intelligibility to the immediate relation which exists between the character of the movement and its meaning, so here also we must presuppose a like relation between the original articulatory movement and its meaning. Then, too, it is not improbable that articulation was at first aided by accompanying mimetic and pantomimetic movements. Evidence in support of this view is to be found in the unrestrained use of such gestures by savages, and in the important part which gestures play in the child's learning to speak. The development of articulate language is, accordingly, in all probability to be thought of as a process of differentiation, in which the articulatory movements have gradually gained the permanent ascendancy over a number of different variable expressive movements which originally attended them. The articulation movements have, then, dispensed with these auxiliary movements as they themselves gained a sufficient degree of fixity. Psychologically the process may be divided into *two* acts. The first consists in the expressive movements of the individual member of the community. These are impulsive volitional acts, among which the movements of the vocal organs gain the ascendancy over the others in the effort of the individual to communicate with his fellows. The second consists in the subsequent associations between sound and idea, which associations gradually become more fixed, and spread from the localities where they originated through wider circles of society.

From the first there are other physical and psychical conditions which take part in the formation of language and produce continual and unceasing modifications in its components. Such modifications may be divided into two classes, namely, *modifications of sound* and *modifications of meaning*.

Modifications of sound have their physiological cause in the gradual changes which take place in the physical structure of the vocal organs. These changes seem to come partly through the influence of the general changes which the transition from a savage to a civilized condition produces in the whole psycho-physical organization, and partly from the special conditions which result from increased practice in the execution of articulatory movements. Many phenomena go to show that the gradually increasing rapidity of articulation is one of the facts of practice which is of especially great influence. Then, too, words which are in any way analogous, act upon one another through direct psychological associations, especially association between verbal ideas which are in any way related, either through sound or through likenesses in both sound and conceptual content (so-called analogous word constructions).

As the change in sound modifies the outer form of words, so the change in meaning modifies the inner content. The original association between a word and the idea it expresses is modified by the substitution of another, different idea. This process of substitution may be several times repeated with the same word. The change in the meaning of words depends, therefore, on a gradual modification of the associative and apperceptive conditions which determine the ideational complications which shall arise in the fixation-point of consciousness when a word is heard or spoken. It may, accordingly, be briefly defined as a shifting of the ideational component of the complication, connected with articulate sound. It is due at times to association, at times to apperception.

These changes in the sound and meaning of words operate together in bringing about the gradual disappearance of the originally necessary relation between sound and meaning, so that a word finally comes to be looked upon as a mere external sign of the idea. This process is so complete that even those verbal forms in which this relation seems to be still retained, that is, in the case of onomato-poetic words, we must recognize the forms themselves as for the most part relatively late products of a secondary assimilative process, which process seeks to reestablish the originally present, but now lost, affinity between sound and meaning.

Another important consequence of this combined action of changes in sound and meaning, is to be found in the fact that many words gradually lose entirely their original concrete sensible significance, and become signs of general concepts and means for the expression of the apperceptive relating and comparing functions and their products.

In this way *abstract thinking* is developed. Such abstract thinking would be impossible without the change in meaning of words upon which it is based, and it is, therefore, a product of the psychical and psycho-physical interactions on which the progressive development of language depends.

Just as components of language, or words, are undergoing a continual modification in sound and meaning, so in the same way, though generally more slowly, changes are going on in the combinations of words into larger wholes, that is, in *sentences*. No language can be thought of without some syntactic order of its words. Sentences and words are, therefore, equally essential forms of thought. Indeed, the sentence is the earlier of the two, for the thought appears at first as a single whole and is later broken up into its components. In the more incomplete stages of language the words of a sentence are, accordingly, only very uncertainly distinguished from each other. There is no universal rule even for the order of words, any more than there is for the relation of sound to meaning. The order which logic favors with a view to the relations of reciprocal logical dependence between concepts, has no psychological universality; it appears, in fact, to be a fairly late product of development, due in part to arbitrary convention, and approached only by the prose forms of some modern languages which are syntactically nearly fixed. The original principle followed in apperceptive combination of words is obviously this, *the order of the words corresponds to the succession of ideas.* As a result those parts of speech which arouse the feelings and attract the attention most intensely are placed first. Following this principle, certain regularities in the order of words are developed in any given community. In fact, such a regularity is to be observed even in the natural gesture language of the deaf and dumb. Still, it is easy to understand that the most various modifications in this respect may appear under special circumstances. In general, however, the habits of association lead more and more to the fixing of particular syntactic forms, so that gradually a certain regularity begins to assert itself through associative attraction exerted by the forms most commonly employed.

B[1]

BY CHARLES DARWIN

Why the organs now used for speech should have been originally perfected for this purpose, rather than any other organs, it is not difficult to see. Ants have considerable powers of intercommunication by means of their antennae, as shown by Huber, who devotes a whole chapter to their language. We might have used our fingers as efficient instruments, for a person with practice can report to a deaf man every word of a speech rapidly delivered at a public meeting; but the loss of our hands, whilst thus employed, would have been a serious inconvenience. As all the higher mammals possess vocal organs, constructed on the same general plan as ours, and used as a means of communication, it was obviously probable that these same organs would be still further developed if the power of communication had to be improved; and this has been effected by the aid of adjoining and well adapted parts, namely the tongue and lips. The fact of the higher apes not using their vocal organs for speech, no doubt depends on their intelligence not having been sufficiently advanced. The possession by them of organs, which with long-continued practice might have been used for speech, although not thus used, is paralleled by the case of many birds which possess organs fitted for singing, though they never sing. Thus, the nightingale and crow have vocal organs similarly constructed, these being used by the former for diversified song, and by the latter only for croaking.[1] If it be asked why apes have not had their intellects developed to the same degree as that of man, general causes only can be assigned in answer, and it is unreasonable to expect anything more definite, considering our ignorance with respect to the successive stages of development through which each creature has passed.

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[1] Taken from *The Descent of Man and Selection in Relation to Sex,* pp. 90–91. New York: D. Appleton & Co., 1874.

C[2]

BY CHARLES H. JUDD

Contrast sound with visual impressions. Visual impressions are cut off in the dark; they are cut off by intervening objects and by a turning of the head of the observer. Sounds travel wherever there is air; they are as easy to produce in the darkness as in daylight; they can easily be varied in intensity. For these reasons they come to be the chief means of social communication, even among the animals. The result is that the vocal cords and the ability to discriminate sounds are highly developed long before the development of language proper.

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[1] Macgillivray, *History of British Birds*, vol. ii, 1839, p. 29. An excellent observer, Mr. Blackwall, remarks that the magpie learns to pronounce single words, and even short sentences, more readily than almost any other British bird; yet, as he adds, after long and closely investigating its habits, he has never known it, in a state of nature, display any unusual capacity for imitation —*Researches in Zoölogy*, 1834, p. 158.

[2] Taken from *Psychology*, p. 215. (Revised edition.) Boston: Ginn Co., 1917.

EXERCISES

1. What are some slang expressions which have resulted from the modification of the sounds of good words? What are some slang expressions that have resulted from modifications of meaning?
2. In one of the foregoing selections there is a description of the advantages of vocal communication. What are some of its limitations?

4. WRITTEN LANGUAGE[1]

BY CHARLES H. JUDD

The earliest stages of writing were those in which pictographic forms were used; that is, a direct picture was drawn upon the writing surface, reproducing as nearly as possible the kind of impression made upon the observer by the object itself (see Fig. 95). To be sure, the drawing used to represent the object was not an exact reproduction or full copy of the object, but it was a fairly direct image. The visual image was thus aroused by a direct appeal to the eye. Anyone could read a document written in this pictographic form if he had ever seen the objects to which the pictures referred. There was no special relation between the pictures or visual forms at this stage of development and the sounds used in articulate language. Concrete examples

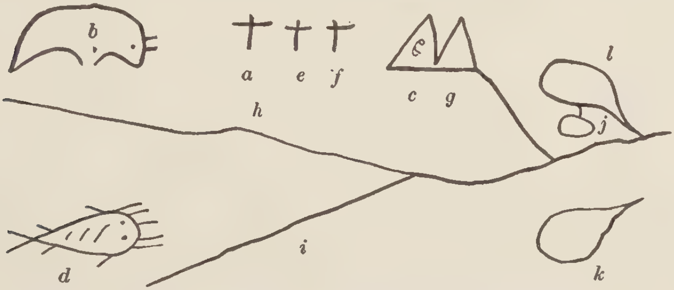

FIG. 95.—An Ojibwa love letter, recorded and explained by Garrick Mallery in the *Annual Report of the Bureau of Ethnology* (1888–1889), p. 363.

The writer, a girl of the Bear totem, *b*, summons her lover, who belongs to the Mud Puppy totem, *d*, along the various trails indicated, to the lodge, *c*, from which the beckoning hand protrudes. The inclosed figures at *l*, *j*, and *k* are lakes. The crosses indicate that the girl and her companions are Christians. "The clear indications of locality," writes Mallery, "serve as well as if in a city a young woman had sent an invitation to her young man to call at a certain street and number."

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[1] Taken from *op. cit.*, pp. 219–23.

of such writing are seen in early monuments, where the moon is represented by the crescent, a king by the drawing of a man wearing a crown. An example of this stage of writing is also supplied by the ancient Chinese forms shown in the upper line of Fig. 96.

Images reduced to lowest terms as powers of reader increase.—The next stage of development in writing began when the pictographic forms were reduced in complexity to the simplest possible lines. The reduction of the picture to a few sketchy lines depended upon the growing ability of the reader to contribute the necessary interpretation. All that was needed in the figure was something which would suggest the idea to the reader's mind. The simplification of the written forms is attained very early, as is seen even in the figures which are used by savage tribes. Thus, to represent the number of an enemy's army, it is not necessary to draw full figures of the forms of the enemy, it is enough if single straight lines are drawn with some brief indication, perhaps at the beginning of the series of lines, to show that these stand each for an individual enemy. This simplification of the drawing leaves the written symbol with very much larger possibilities of entering into new relations in the mind of the reader. Instead, now, of being a specific drawing related to a specific object, it invites by its simple character a number of different interpretations. A straight line, for example, can represent not only the number of an enemy's army, but it can represent also the number of sheep in a flock, or the number of tents in a village, or anything else which is capable of enumeration. The use of a straight line for these various purposes stimulates new mental developments. This is shown by the fact that the development of the idea of the number relation, as distinguished from the mass of possible relations in which an object may stand, is greatly

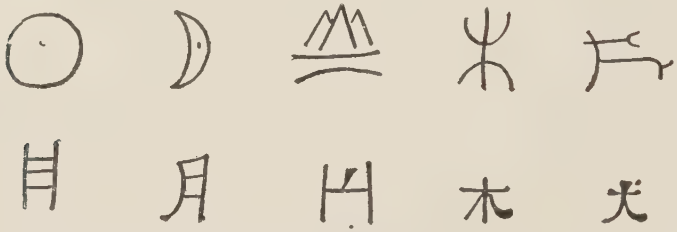

FIG. 96.—Ancient and modern Chinese writing.

The upper line shows ancient forms of Chinese writing; the lower line shows the derived modern forms. Reading from left to right, the characters signify "sun," "moon," "mountain," "tree" (or "wood"), "dog."

facilitated by this general written symbol for numbers. The intimate relation between the development of ideas on the one hand and the development of symbols on the other is here very strikingly illustrated. The drawing becomes more useful because it is associated with more elaborate ideas, while the ideas develop because they find in the drawing a definite content which helps to mark and give separate character to the idea. Striking examples of the simplification of form in order to facilitate the writing of symbols are shown in Figs. 96 and 97.

Written symbols and their relation to sounds.—As soon as the drawing began to lose its significance as a direct perceptual reproduction of the object and took on new and broader meanings through the associations which attached to it, the written form became a symbol rather than a direct appeal to visual memory. As a symbol it stood for something which, in itself, it was not. The way was thus opened for the written symbol to enter into relation with oral speech, which is also a form of symbolism (see Fig. 97). Articulate sounds are simplified forms of experience capable through association with ideas of expressing meanings not directly related to the sounds themselves. When the written symbol began to be related to the sound symbol, there was at first a loose and irregular relation between them. The Egyptians seem to have established such relations to some extent. They wrote at times with pictures standing for sounds as we now write in rebus puzzles. In such puzzles the picture of an object is intended to call up in the mind of the reader not the special group of ideas appropriate to the object represented in the picture but rather the sound which serves as the name of this object. When the sound is once suggested to the reader, he is supposed to attend to that and to connect with it certain other associations appropriate to the sound. To take a modern illustration, we may, for example, use the picture of the eye to stand for the first personal pronoun. The relationship between the picture and the idea for which it is used is in this case through the sound of the name of the object depicted. That the early alphabets are of this type of rebus pictures appears in their names. The first three letters of the Hebrew alphabet, for example, are named, respectively, *aleph*, which means "ox," *beth*, which means "house," and *gimmel*, which means "camel."

The alphabet.—The complete development of a sound alphabet from this type of rebus writing required, doubtless, much experimentation on the part of the nations which succeeded in establishing the association. The Phoenicians have generally been credited with the invention of the forms and relations which we now use. Their contribution to civilization cannot be overestimated. It consisted not in the presentation of new material or content to conscious experience but rather in bringing together by association groups of contents which, in their new relation, transformed the whole process of thought and expression. They associated visual and auditory content and gave to the visual factors a meaning which originally attached to the sound. Pictures thus came to mean sounds rather than objects (see Fig. 97).

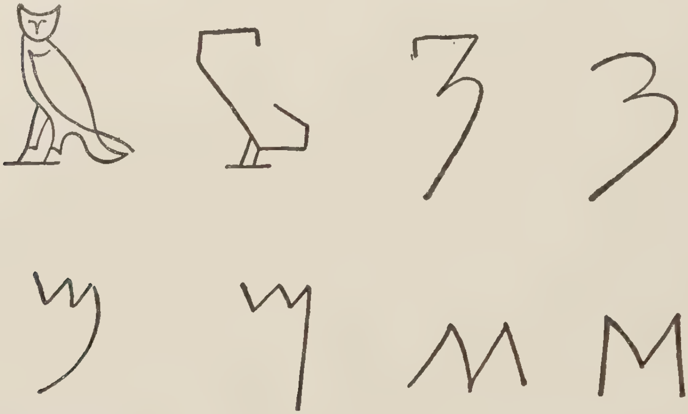

FIG. 97.—Derivation of the Roman letter M from the ancient Egyptian hieroglyphic owl.

The four forms in the upper part of the figure are Egyptian forms. The first on the left is the usual hieroglyphic picture of the owl, or, as it was called in the Egyptian language, *mulak*. The three remaining upper forms are found in the writings of the Egyptian priests. The first form on the left of the lower series is an ancient Semitic form. Then follow in order an ancient Greek form and two later Greek forms. (From I. Taylor's "The Alphabet," pp. 9, 10.)

EXERCISE

1. Suppose that we had a special written sign for each word in our language. What effect would you expect this to have upon intellectual life and development?

5. NUMBERS AND COUNTING[1]

BY EDWARD B. TYLOR

Even those who cannot talk can count, as was well shown by the deaf-and-dumb lad Massieu, who wrote down among the recollections of his childhood before the Abbé Sicard educated him, "I knew the numbers before my instruction; my fingers had taught me them." We ourselves as children began arithmetic on our fingers and now and then take to them still, so that there is no difficulty in understanding how a savage whose language has no word for a number above three will manage to reckon perhaps a list of fifteen killed and wounded, how he will check off one finger for each man, and at last hold up his hand three times to show the result. The next question is, how numeral words came to be invented. This is answered by many languages, which show in the plainest way how counting on fingers and toes led to making numerals. When a Zulu wants to express the number six, he says *tatisitupa*, which means "taking the thumb"; this signifies that the speaker has counted all the fingers of his left hand, and begun with the thumb of the right. When he comes to seven, for instance when he has to express that his master bought seven oxen, he will say *u kombile*, that is, "he pointed"; this signifies that in counting he had come to the pointing-finger or forefinger. In this way the words "hand," "foot," "man," have in various parts of the world become numerals. An example how they are worked may be taken from the language of the Tamanacs of the Orinoco; here the term for five means "whole hand," six is "one of the other hand," and so on up to ten or "both hands"; then "one to the foot" is eleven, and so on to "whole foot" or fifteen, "one to the other foot" or sixteen, and thence to "one man" which signifies twenty, "one to the hands of the next man" being twenty-one, and the counting going on in the same way to "two men" which stands for forty, etc., etc. Now this state of things teaches us a truth which has sometimes been denied, that the lower races of men have, like ourselves, the faculty of progress or self-improvement. It is evident that there was a time when the ancestors of these people had in their languages no word for fifteen or sixteen, nor even for five or six, for if they had they could not have been so stupid as to change them for their present clumsy phrases about hands and feet and men. We see back to the time when, having no means of reckoning such numbers except on their fingers and toes, they found they had only to describe in words what they were doing, and such a phrase as "both hands" would serve them as a numeral for ten. Then they would keep up these as numerals after their original sense was lost, like the Vei negroes who called the number twenty *mo bande*, but had forgotten that this must have meant "a person finished." The languages of nations long civilized seldom show such plain meaning in their numerals, perhaps because they are so ancient and have undergone such change. But all through the languages of the world, savage or civilized, with exceptions too slight to notice here, there is ineffaceable proof that the numerals arose out of the primitive counting on fingers and toes. This always led men to reckon by fives, tens, and twenties, and so they reckon still. The quinary kind of counting (by fives) is that of tribes like the negroes of Senegal, who count one, two, three, four, five, five-one, five-two, etc.; we never count numbers thus in words, but we write them so in the Roman numerals. The decimal counting (by tens) is the most usual in the world, and our ordinary counting is done by it, thus eighty-three is "eight tens and three." The vigesimal counting (by twenties) which is the regular mode in many languages, has its traces left in the midst of the decimal counting of civilized Europe, as in English "fourscore and three," French "quatre-vingt trois," that is "four twenties and three." Thus it can hardly be doubted that the modern world has inherited direct from primitive man his earliest arithmetic worked on nature's counting-board—the hands and feet. This also explains why the civilized world uses a numeral system based on the inconvenient number, which will not divide either by three or four. Were we starting our arithmetic afresh, we should more likely base it on the duodecimal notation, and use dozens and grosses instead of tens and hundreds.

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[1] Taken from *Anthropology, an Introduction to the Study of Man and Civilization*, pp. 309–16. New York: D. Appleton & Co., 1916.

To have named the numbers was a great step, but words hardly serve beyond the very simplest arithmetic, as any one may satisfy himself by trying to multiply "seven thousand eight hundred and three" by "two hundred and seventeen" in words, without helping himself by turning them in thought into figures. How did men come to the use of numeral figures? To this question the beginning of an answer may be had from barbaric picture-writing, as where a North American warrior will make four little marks //// to show that he has taken four scalps. This is very well for the small numbers, but becomes clumsy for higher ones. So already when writing was in its infancy, the ancients had fallen upon the device of making special marks for their fives, tens, hundreds, etc., leaving the simple strokes to be used only for the few units over. This is well seen in Fig. 98 which shows how numeration was worked in ancient Egypt and Assyria. Nor has this old method died out in the world, for the Roman numerals I, V, X, L, still in common use among ourselves, are arranged on much the same principle. Another device, which arose out of the alphabet, was to take the letters in their order to stand for numbers. Thus the sections of Psalm CXIX are numbered by the letters of the Hebrew alphabet, and the books of the Iliad by the letters of the Greek alphabet. By these various plans the arithmetic of the ancient civilized nations made great progress. Still their numeration was very cumbrous in comparison with that of the modern world. Let us put down MMDCLXIX and multiply by CCCXLVIII, or β,χ′ξ′θ′ by τ′μ′η′ and a few minutes' trial will not fail to convince us of the superiority of our ciphers.

To understand how the art of ciphering came to be invented, it is necessary to go back to a ruder state of things. In Africa, negro traders may be seen at market reckoning with pebbles, and when they come to five, putting them aside in a little heap. In the South Sea Island it has been noticed that people reckoning, when they came to ten, would not put aside a heap of ten things, but only a single bit of coco-nut stalk to stand for ten, and then a bigger piece when they wanted to represent ten tens or a hundred. Now to us it is plain that this use of different kinds of markers is unnecessary, but that all the reckoner with little stones or beans has to do, is to keep separate his unit-heap, his ten-heap, his hundred-heap, etc. This use of such things as pebbles for "counters," which still survives in England among the ignorant, was so common in the ancient world, that the Greek word for reckoning was *psēphizein*, from *psēphos*, a pebble, and the corresponding Latin word was *calculare* from *calculus*, a pebble, so that our word *calculate* is a relic of very early arithmetic. Now to work such pebble-counting in an orderly manner, what is wanted is some kind of abacus or counting-board with divisions. These have been made in various forms, as the Roman abacus with lines of holes for knobs or pegs, or the Chinese swan-pan with balls strung on wires, on which the native calculators in the merchants' counting-houses reckon with a speed and exactness that fairly beats the European clerk with his pencil and

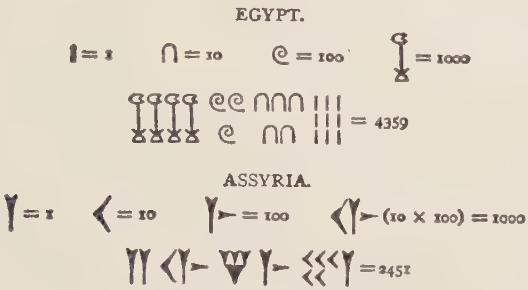

FIG. 98.—Ancient Egyptian and Assyrian numeration

paper. It may have been from China that the Russian traders borrowed the ball-frame on which they also do their accounts, and it is said that a Frenchman noticing it in Russia at the time of Napoleon's invasion was struck with the idea that it would serve perfectly to teach little children arithmetic; so he introduced it in France, and thence it found its way into English infants' schools. Now whatever sort of abacus is used, its principle is always the same, to divide the board or tray into columns, so that in one column the stones, beans, pegs, or balls, stand for units, in the next column they are tens, in the next hundreds, and so on, Fig. 99. Here the three stones in the right-hand column stand for 3, the nine in the next column for 90, the one in the fourth column for 1,000 and so on. The next improvement was to get rid of the troublesome stones or beans, and write down numbers in the columns, as is here shown with Greek and Roman numerals. But now the calculator could do without the clumsy board, and had only to rule lines on his paper, to make columns for units, tens, hundreds, etc. The reader should notice that it is not necessary to the principle of the abacus that each column should stand for ten times the one next it. It may be twelve or twenty or any other number of times, and in fact the columns in our account-books for £ *s. d.* or *cwts. qrs. lbs.*, are surviving representatives of the old method of the abacus. Such reckoning had still the defect that the numbers could not be taken out of the columns, for even when each number from one to nine has a single figure to stand for it, there would still be here and there an empty column (as is purposely left in Fig. 99) which would throw the whole into confusion. To us now it seems a very simple thing to put a sign to show an empty column, as we have learned to do with the zero or 0, so that the number expressed in the picture of the abacus can be written down without any columns, 241093. This invention of a sign for nothing was practically one of the greatest moves ever made in science. It is the use of the zero which makes the difference between the old arithmetic and our easy ciphering. We give the credit of the invention to the Arabs by using the term Arabic numerals, while the Arabs call them Indian, and there is truth in both acknowledgments of the nations having been scholars in arithmetic one to the

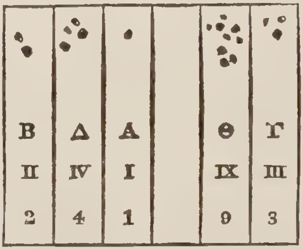

Fig. 99.—Mode of calculation by counters and by figures on abacus.

other. But this does not go to the root of the matter, and it is still unsettled whether ciphering was first devised in Asia, or may be traced further back in Europe to the arithmeticians of the school of Pythagoras. As to the main point, however, there is no doubt, that modern arithmetic comes out of ancient counting on the columns of the abacus, improved by writing a dot or a round o to show the empty column, and by this means young children now work calculations which would have been serious labour to the arithmeticians of the ancient world.

EXERCISES

1. Why is it more difficult to multiply XXXIV by XXIX without changing to Arabic numerals in the process than 34 by 29?
2. What are some arguments for or against the duodecimal system not mentioned by Tylor?

6. DEVELOPMENT OF LANGUAGE IN THE INDIVIDUAL[1]

BY AMY ELIZA TANNER

After the child by his instinctive babblings and persistent imitation has learned to speak words, he learns to use them with a significance from constantly hearing one word used in connection with a given object. In so far as the same word is used for different objects or situations, he is left helplessly struggling for the common meaning hidden beneath all this diversity; and again when different words are used with the same meaning, as in the various forms of be, he is led astray into seeking differences where none exist.

Hence comes the value of language as an aid in the development of concepts, and as a revealer to us of their growth in the child's mind. At first he uses words in altogether too wide a sense. "Mamma," "bath," "wow-wow," are applied not only to the particular objects he knows, but to all that in any degree resemble them. The child does not see differences distinctly enough to mark off individuals unless there is some striking characteristic to aid him. He rather associates the word with the whole situation in which it is used, and oftentimes with all the details of it. Thus Romanes gives the case of a child who saw a duck on the water, and called it "quack." After that he called all birds and insects "quack" and also all liquids. Still later, he saw an eagle on a piece of money and called it "quack" again. Lindner's daughter when asking for an apple, was taught

[1] Taken by permission from *The Child, His Thinking, Feeling and Doing*, pp. 332–35. Chicago: Rand, McNally & Co., 1903.

to say "apple," and thereafter used the word as meaning *eat*. Another child used the word "ta-ta" to say good-by; then when anything was taken away; then for the blowing out of a light. Still another used "hat" for anything put on his head, including a brush and comb. Dipping bread in gravy is called a "bath." The palate is the "teeth roof"; the road is the "go"; the star is the "eye"; all metals are "keys," etc.

In all such cases we notice that the child is trying to classify, and must use what he already has in the way of words to aid him. So also with relations—a much more difficult thing, and one in which a child is likely to get confused. A child will have a vague idea of quantity, but can not at first express or understand too much and too little, too big and too small, etc. He may get them in one situation, but when the same object that is too big for one thing is too small for another, it is beyond him. Here is the root of his trouble with "I" and "you." It is not surprising that little George thought "the Doctor came and shook his (Willie's) head and gave him nasty physic, too." "Buy" and "sell," "lend" and "borrow," "teach" and "learn," are thus all pitfalls for him, and at first are confused. Here again we can trace the race parallel. Many people use "learn" for "teach" and we apply "pleasant," "sore," etc., both to our feelings and the object that causes them. Our abstract words also bear unmistakable marks of their concrete origin. "Spirit" is "breath"; "wrong" is "awry," "twisted," or "bitter"; "right" is "straight," and so on through the list.

Process of limitation.—In his hasty generalizing the child makes many mistakes in his conclusions, and so a process of limiting or correcting old concepts and of more carefully forming new ones begins. A good example of such limitation is given by Darwin. His son called *food* "mum," *sugar* was "shumum," and *licorice,* "black shu mum." Such words as "teeth roof" for palate "eye curtain" for eyelid, "tell wind" for weather-vane, show both generalization and limitation. On the other hand, of course, if the child's experience of a word is too narrow, he will make ludicrous mistakes in over-limitation. Thus one boy said that the good Samaritan poured paraffin into the wounds of the sick man. Oil meant only paraffin to him. The child who entreated his mother to "buy him a brother while they were cheap at the show because children were half-price," labored under a similar difficulty. Perhaps also the strict insistence of little children on exactly the same words in retailing a story shows their feeling of a strangeness with words. When Mr. Two-and-a-half-years is asked, "Shall I read to you out of this book?" he answers, "No, but something inside of it," because that is what he wants.

Love of nonsense songs, and of Mother Goose, and the making up of nonsense rhymes mark this period also, which may begin as early as three and a half years. A little child will often sit by himself singing over lists of word: *mam*, *pam*, *tam*, *sam*, *jam*, etc., taking an immense delight in it. Sometimes he will rhyme his answers to your questions, or make all his conversation rhythmical.

With the process of narrowing or limitation well marked, the child's way is comparatively clear before him. It is thenceforth the usual process of the formation of correct concepts as traced by Baldwin. An object is first given which is both percept and concept. When other objects are presented like this in some respects, the same word is used for all, until the child fails to get what he wants by this common word, and so is forced to make species and varieties to go under the larger class. In the expression of the ideas, he uses the words that he knows, making new and quaint combinations, but little by little imitation teaches him the conventional signs, and he drops the original forms.

EXERCISE

1. Give some examples of erroneous uses of words due to over-generalization and to over-limitation of their meanings.

7. CHANGES IN MEANING OF WORDS[1]

BY EDWIN E. SLOSSON

Language is a circulating medium, as money is, and words, like coins, are apt to lose their value in the course of time. A decline in the exchange rating of a word may be due either to inflation, that is, too promiscuous application, or to a growing popular suspicion of the soundness of its backing.

The Seven Wise Men of early Greece were called "sophists" as an honorific appellation. But later a "sophist" came to mean a man who pretended to know more than he did or, worse, who sold his wisdom to the highest bidder for the basest of purposes, that of making a wrong cause seem right.

Pythagoras repudiated the title of sophist, or wise man, because, as he said, "none is wise save God." So he devised and assumed the more modest sounding term of "philosopher," a lover of wisdom. But this term has narrowed, if not degenerated. Philosophy, once the sum total of human knowledge, has come, in common parlance, to be confined to speculative metaphysics. When Plato said that states should be ruled by philosophers he did not mean by professors of metaphysics.

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[1] "How Words Lose Reputation," *Scientific Monthly*, XVI (1923), 445-47.

This degenerative process has gone so far that we have no word in good repute and common usage to apply to a group of competent and learned men. The word "scholars" would once have served, but this has fallen from its high estate and come to mean "pupils," that is, those who are being schooled, instead of those who have been schooled. To call a man a "sage" calls up in the average mind the picture of something grey and pedantic, if not green and aromatic. The word "scientist" has become so narrowed and lowered and misapplied that men of science hesitate to use it longer. The titles of "professor" and "expert" are also distinctly losing caste.

To call a man a "fellow" is not safe now-a-days outside of the campus of a university.

It is hard to arrest a word when it is on the down grade and almost impossible for a word to regain a reputation once lost. It seems that some sort of gravitational force prevails in linguistics. The dictionary is crowded with words that once moved in the highest circles, but now are outcast and marked "obs." or "vul."

The man who knows comes in the course of time to be considered a "knowing man," with the suspicion of knowing too much for his neighbors. The "kenning man" becomes the "cunning man." A master of arts gets the reputation of being "artful." A craftsman is regarded as "crafty." A politician has come to mean—well, a politician.

Four hundred years ago the word "virago" meant a heroic woman and was esteemed a fitting name to apply to Eve, the mother of all living. Now-a-days no one would dare call a woman a virago to her face if she were one. "Hussy" has degenerated in a hundred years from a thrifty "housewife" to quite the opposite.

In Australian newspapers to-day you may see a lonely bachelor advertising for "a homely wife," not because he has an aversion to feminine beauty, but because he desires domesticity.

A "wretch" was not at all wretched on the start. Othello calls his beloved Desdemona "Excellent wretch." A modern maiden would not feel complimented by such a term of endearment.

A "prude" was merely a prudent person.

A "villain" and a "boor" once meant simply a country man, not necessarily wicked or even rude. A "knave" was a simple servant. A "varlet" was a candidate for knighthood. A "miscreant" meant one who differed from you in theology.

In 1548 it was proper to express the pious wish "that his son, Prince Edward, that good imp, may long reign over you." How is it that "imp" has since come to mean a little devil?

So, as we see, words generally degenerate as they grow old. That does not matter much, for we can always make new words so long as the alphabet holds out. I am not concerned over the loss of a name, but I am with the loss of the type that the name once signified. If an ancient and honorable title falls into disrepute it is not altogether without reason. It means that some at least of those who bore it have not lived up to its true meaning.

It would be a profitable exercise to consider such cases as occur to us of words that we see are gradually becoming lowered or limited and try to discover the cause of their decline and how it may be prevented.

EXERCISE

1. Enumerate some of the reasons why certain slang expressions (use concrete illustrations) come into such wide use.

8. LANGUAGE AND THOUGHT

A[1]

BY THE MOST REVEREND WILLIAM, LORD ARCHBISHOP OF YORK

A discovery can hardly be said to be secured, until it has been marked by a name which shall serve to recall it to those who have once mastered its nature, and to challenge the attention of those to whom it is still strange. Such words as inertia, affinity, polarisation, gravitation, are summaries of so many laws of nature, and are so far happily chosen for their purpose, that, except perhaps the third, each of them guides us by its etymology towards the nature of the law it stands to indicate. When Gay-Lussac and Mitscherlich discovered that some chemical substances either crystallise in the same form, or may be substituted for one another in compounds without change in the form which the compounds assume, they were not content with a statement of this beautiful and instructive law, but they invented the name of *isomorphism* (tendency to equal forms) to be an index and summary of the law and the experiments that illustrated it. When two opposite theories of medicine are termed Homoeopathy and Allopathy, these two compound words contain in fact an account of the opposing theories. A recent popular and instructive book has reminded us that it is possible to exhume from under the words that are their monuments many a buried and forgotten theory. Thus we speak of a jovial, a saturnine, or a mercurial temper, without remembering that this implies an ascription of its qualities to the planet Jove or Saturn or Mercury. Physiologists now ignore the systems from which such terms as animal spirits, good humour, vapours, proceed. But if words often serve as tombstones, and remain when the theory has mouldered away, they are as often the keys by which we unlock the casket of the living and precious discovery, to exhibit it to the world. On the other hand, our eminent anatomist, Professor Owen, complains of the embarrassments produced in his science, by having to use a description where a name would serve; for instance, a particular bone is called by Soemmering "pars occipitalis stricte sic dicta partis occipitalis ossis spheno-occipitalis," a description so clumsy that we may be certain the bone will not be mentioned more frequently than absolute need requires. In many cases, the privilege of giving the name which all the world shall employ, is conceded to the man or the nation who first clearly perceives the attributes, sees that they make one notion, and determines how it shall be designated. We are indebted to the finer observation of the French for the names *ennui*, *naïveté*, and *finesse*, for which we have given our own *comfortable* in exchange: and an Englishman may notice with a smile of satisfaction that *das gentlemanlike* makes its appearance in a German author.

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[1] Taken from *An Outline of the Laws of Thought*, pp. 33–37. London: Longmans, Green & Co., 1867.

But it is not only in the higher laws of science, or the more subtle qualities which social refinement develops in men and in society, that the power of naming is the power of fixing the fleeting colours of thought. So long as we are content with the bare reception of visual impressions, we can in a measure dispense with words, because our remembrance of the image of each object will serve instead of its name to ourselves, and a picture of it may represent it, though by a cumbrous and difficult process, to the minds of others. But thought never stops with the mere inspection of objects. In the simplest case, we proceed to *decompose* the sensitive impression into its parts. The tree which our eyes behold is found, upon reflection, to be tall or stunted, blooming or withered, old or young, straight or gnarled, waving in the wind or still; and these properties have no independent existence, but are parts of the visible object; they are *entia rationis*, and exist separately in the mind alone. Whence, then, is our power of recalling them with such marvellous precision and facility? How is it that we can keep them safely apart in the mind, instead of being obliged to look for them mingled and confused, in the objects from which we first disentangled them by reflection? By virtue of the name we have attached to each of them; which, like the labels upon the chemist's jars or the gardener's flowerpots, enable us at once to identify and secure the property we seek. Names then are the means of fixing and recording the result of trains of thought, which without them must be repeated frequently, with all the pain of the first effort.

Leibnitz was the first, so far as I know, to call attention to the fact that words are sometimes more than signs of thought; that they may become thoughts. His distinction between *symbolical* and *intuitive* [*notative*] conceptions conducts us to the third function of language, that it abbreviates the processes of thought. Where our notion of any object or objects consists of a clear insight into all the attributes, or at least the essential ones, he would call it intuitive. But where the notion is complex, and its properties numerous, we do not commonly realise all that it conveys; the process of thinking would be needlessly retarded by such a review. We make use of the name commonly given to the notion, as a symbol, even for ourselves, of all the properties it possesses. A name then, employed in thought, is called a *symbolical cognition;* and the names we employ in speech are not always symbols to another of what is explicitly understood by us, but quite as often are symbols both to speaker and hearer, the full and exact meaning of which neither of them stops to unfold, any more than they regularly reflect that every sovereign which passes through their hands is equivalent to 240 pence. Such words as the state, happiness, liberty, creation, are too pregnant with meaning for us to suppose that we realise their full sense every time we read or pronounce them. If we attend to the working of our minds we shall find that each word may be used, and in its proper place and sense, though perhaps few or none of its attributes are present to us at the moment. A very simple notion is always intuitive: we cannot make our notion of brown or red simpler than it is, by any symbol. On the other hand a highly complex notion, like those named above, is seldom fully realised —seldom other than symbolical. Here then is a further use of names; they serve to abbreviate the process of thought, as we have seen that they are useful in recording its results. And it may be noticed here that this distinction of cognitions throws a new light on the nature of definitions, or explanatory propositions, which are not, as they are often regarded, mere explanations to others of a meaning which we ourselves duly apprehend, but are real acts of thought, which by unfolding before us some marks of our conception, partially or wholly unseen by us, have all the power of new truths even for ourselves.

B[1]

BY F. M. MÜLLER

One of the questions which I have been asked most frequently is: If thought is identical with language, what about deaf and dumb people? Are they unable to think because they are unable to speak?

My answer it, first of all, that deaf and dumb people are exceptions, and we must not allow our general arguments to be influenced by a few anomalies. Secondly, I have the authority of the best judges, such as Professor Huxley, for stating that a man born dumb, notwithstanding his great cerebral mass and his inheritance of strong intellectual instincts, would be capable of few higher intellectual manifestations than an orang or a chimpanzee if he were confined to the society of dumb associates. Thirdly, we must remember that words are not the only embodiment of thought. Holding up three fingers is as good a sign for the addition of one, one, one, as the sound of three. Shaking the fist in the face is as expressive as saying "Don't." Hieroglyphic writing shows us how our thoughts may be embodied in signs without any reference to the sound of spoken words, and Chinese is read and understood perfectly by people who, when they pronounce and speak it, are quite unintelligible to each other.

It is by means of signs appealing to the sense of sight, and not at first to the sense of hearing, that deaf and dumb people are educated and thus become what they were meant to be, rational beings.

C[2]

BY HELEN KELLER

The morning after my teacher came she led me into her room and gave me a doll.[3] The little blind children at the Perkins Institution had sent it and Laura Bridgman had dressed it; but I did not know this until afterward. When I had played with it a little while, Miss Sullivan slowly spelled into my hand the word "d-o-l-l." I was at once interested in this finger play and tried to imitate it. When I finally succeeded in making the letters correctly I was flushed with childish pleasure and pride. Running downstairs to my mother I held up my hand and made the letters for doll. I did not know that I was spelling a word or even that words existed; I was simply making my fingers go in monkey-like imitation. In the days that followed I learned to spell in this uncomprehending way a great many words, among them *pin*, *hat*, *cup* and a few verbs like *sit*, *stand* and *walk*. But my teacher had been with me several weeks before I understood that everything has a name.

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[1] Taken from *Three Introductory Lectures on The Sciences of Thought, etc.*, pp. 92–93. Chicago: Open Court Publishing Co., 1888.

[2] Taken from *The Story of My Life*, pp. 22–24. Garden City, N.Y.: Doubleday, Page & Co., 1922.

[3] Helen Keller lost her sight and hearing during an illness when she was 19 months old. She is a graduate of Radcliffe College and has gained considerable fame as a writer and lecturer.—EDITOR.

One day, while I was playing with my new doll, Miss Sullivan put my big rag doll into my lap also, spelled "d-o-l-l" and tried to make me understand that "d-o-l-l" applied to both. Earlier in the day we had had a tussle over the words "m-u-g" and "w-a-t-e-r." Miss Sullivan had tried to impress it upon me that "m-u-g" is *mug* and that "w-a-t-e-r" is *water*, but I persisted in confounding the two. In despair she had dropped the subject for the time, only to renew it at the first opportunity. I became impatient at her repeated attempts and, seizing the new doll, I dashed it upon the floor. I was keenly delighted when I felt the fragments of the broken doll at my feet. Neither sorrow nor regret followed my passionate outburst. I had not loved the doll. In the still, dark world in which I lived there was no strong sentiment or tenderness. I felt my teacher sweep the fragments to one side of the hearth, and I had a sense of satisfaction that the cause of my discomfort was removed. She brought me my hat, and I knew I was going out into the warm sunshine. This thought, if a wordless sensation may be called a thought, made me hop and skip with pleasure.

We walked down the path to the well-house, attracted by the fragrance of the honeysuckle with which it was covered. Someone was drawing water and my teacher placed my hand under the spout. As the cool stream gushed over one hand she spelled into the other the word *water*, first slowly, then rapidly. I stood still, my whole attention fixed upon the motions of her fingers. Suddenly I felt a misty consciousness as of something forgotten—a thrill of returning thought; and somehow the mystery of language was revealed to me. I knew then that "w-a-t-e-r" meant the wonderful cool something that was flowing over my hand. That living word awakened my soul, gave it light, hope, joy, set it free! There were barriers still, it is true, but barriers that could in time be swept away.[1]

I left the well-house eager to learn. Everything had a name, and each name gave birth to a new thought. As we returned to the house every object which I touched seemed to quiver with life. That was because I saw everything with the strange, new sight that had come to me. On entering the door I remembered the doll I had broken. I felt my way to the hearth and picked up the pieces. I tried vainly to put them together. Then my eyes filled with tears; for I realized what I had done, and for the first time I felt repentance and sorrow.

I learned a great many new words that day. I do not remember what they all were; but I do know that *mother*, *father*, *sister*, *teacher* were among them—words that were to make the world blossom for me, "like Aaron's rod, with flowers." It would have been difficult to find a happier child than I was as I lay in my crib at the close of that eventful day and lived over the joys it had brought me, and for the first time longed for a new day to come.

D[2]

BY ANNE MANSFIELD SULLIVAN

On March 31st I found that Helen knew eighteen nouns and three verbs. Here is a list of the words. Those with a cross after them are words she asked for herself: *Doll*, *mug*, *pin*, *key*, *dog*, *hat*, *cup*, *box*, *water*, *milk*, *candy*, *eye* (×), *finger* (×), *toe* (×), *head* (×), *cake*, *baby*, *mother*, *sit*, *stand*, *walk*. On April 1st she learned the nouns *knife*, *fork*, *spoon*, *saucer*, *tea*, *papa*, *bed*, and the verb *run*.

April 5, 1887

I must write you a line this morning because something very important has happened. Helen has taken the second great step in her education. She has learned that *everything has a name, and that the manual alphabet is the key to everything she wants to know.*

In a previous letter I think I wrote you that "mug" and "milk" had given Helen more trouble than all the rest. She confused the nouns with the verb "drink." She didn't know the word for "drink," but went through the pantomime of drinking whenever she spelled "mug" or "milk." This morning, while she was washing, she wanted to know the name for "water." When she wants to know the name of anything, she points to it and pats my hand. I spelled "w-a-t-e-r" and thought no more about it until after breakfast. Then it occurred to me that with the help of this new word I might succeed in straightening out the "mug-milk" difficulty. We went out to the pump-house, and I made Helen hold her mug under the spout while I pumped. As the cold water gushed forth, filling the mug, I spelled "w-a-t-e-r" in Helen's free hand. The word coming so close upon the sensation of cold water rushing over her hand seemed to startle her. She dropped the mug and stood as one transfixed. A new light came into her face. She spelled "water" several times. Then she dropped on the ground and asked for its name and pointed to the pump and the trellis, and suddenly turning round she asked for my name. I spelled "Teacher." Just then the nurse brought Helen's little sister into the pump-house, and Helen spelled "baby" and pointed to the nurse. All the way back to the house she was highly excited, and learned the name of every object she touched, so that in a few hours she had added thirty new words to her vocabulary. Here are some of them: *Door*, *open*, *shut*, *give*, *go*, *come*, and a great many more.

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[1] See Miss Sullivan's letter below.

[2] Taken from *op. cit.*, pp. 315–18.

P.S.—I didn't finish my letter in time to get it posted last night; so I shall add a line. Helen got up this morning like a radiant fairy. She has flitted from object to object, asking the name of everything and kissing me for very gladness. Last night when I got in bed, she stole into my arms of her own accord and kissed me for the first time, and I thought my heart would burst, so full was it of joy.

April 10, 1887

I see an improvement in Helen from day to day, almost from hour to hour. Everything must have a name now. Whenever we go, she asks eagerly for the names of things she has not learned at home. She is anxious for her friends to spell, and eager to teach the letters to every one she meets. She drops the signs and pantomime she used before, as soon as she has words to supply their place, and the acquirement of a new word affords her the liveliest pleasure. And we notice that her face grows more expressive each day.

I have decided not to try to have regular lessons for the present. I am going to treat Helen exactly like a two-year old child. It occurred to me the other day that it is absurd to require a child to come to a certain place at a certain time and recite certain lessons, when he has not yet acquired a working vocabulary. I sent Helen away and sat down to think. I asked myself, "*How does a normal child learn language?*" The answer was simple. "By imitation." The child comes in the world with the ability to learn, and he learns of himself, provided he is supplied with sufficient outward stimulus. He sees people do things, and he tries to do them. He hears others speak, and he tries to speak. *But long before he utters his first word, he understands what is said to him.* I have been observing Helen's little cousin lately. She is about fifteen months old, and already understands a great deal. In response to questions she points out prettily her nose, mouth, eye, chin, cheek, ear. If I say, "Where is baby's other ear?" she points it out correctly. If I hand her a flower, and say, "Give it to mamma," she takes it to her mother. If I say, "Where is the little rogue?" she hides behind her mother's chair, or covers her face with her hands and peeps out at me with an expression of genuine roguishness. She obeys many commands like these: "Come," "Kiss," "Go to papa," "Shut the door," "Give me the biscuit." But I have not heard her try to say any of these words, although they have been repeated hundreds of times in her hearing, and it is perfectly evident that she understands them. These observations have given me a clue to the method to be followed in teaching Helen language. *I shall talk into her hand as we talk into the baby's ears.* I shall assume that she has the normal child's capacity of assimilation and imitation. *I shall use complete sentences in talking to her*, and fill out the meaning with gestures and her descriptive signs when necessity requires it; but I shall not try to keep her mind fixed on any one thing. I shall do all I can to interest and stimulate it, and wait for results.

April 24, 1887

The new scheme works splendidly. Helen knows the meaning of more than a hundred words now, and learns new ones daily without the slightest suspicion that she is performing a most difficult feat. She learns because she can't help it, just as the bird learns to fly. But don't imagine that she "talks fluently." Like her baby cousin, she expresses whole sentences by single words. "Milk," with a gesture means, "Give me more milk." "Mother," accompanied by an inquiring look, means "Where is mother?" "Go" means, "I want to go out." But when I spell into her hand, "Give me some bread," she hands me the bread; or if I say, "Get your hat and we will go to walk," she obeys instantly. The two words, "hat" and "walk" would have the same effect; *but the whole sentence, repeated many times during the day, must in time impress itself upon the brain, and by and by she will use it herself.*

EXERCISE

1. Why would it be impossible to think about gravity, acceleration, evolution, justice, without names for those conceptions?

CHAPTER XVI

THINKING

1. MEANINGS AS ATTITUDES OR RESPONSES

A[1]

BY T. L. BOLTON

The problem of meaning comes up in connection with the subject of conception. However no advance has been made when it is shown that meaning and conception are identical. Something more fundamental must be sought. This may be found in the instinctive reactions of the lower animals which reappear in the higher animals as adjustments and attitudes. The instinctive response that objects evoke are the meanings of the objects for the animals. There seems to be little doubt but that human beings tend to assume in the presence of objects attitudes or adjustments that are characteristic of the objects. It is then the attitude that gives meaning to the object. In this way an object may be given many different meanings and many different objects may get one and the same meaning. Let us take a given object and conceive it as fuel; it will then be burned for heating purposes. Let us now conceive the same object as food and it will now be eaten. Again we will conceive it as merchandise and place it upon sale, deliver or ship it to a customer. This object is commonly called 'corn' and it has been conceived in these various ways in the western country. You sit at table and a piece of chinaware before you is conceived as a saucer and it is placed under your coffee cup. A few moments later the same piece of ware is conceived as an ash tray and you knock the ashes from your cigar into it. In each and every case the object becomes what it is conceived to be by acting upon it as you would act upon the object which it is commonly conceived to be. What the object means is determined by the adjustment that is made to it. Let a child be asked what a given thing is and he will show what the thing does or what he does with it. Ask the same question of an Indian and he will give a like answer. Sign language is still in great part an imitation of a movement made by an object or of the movements made by a person in the presence of the object.

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[1] Taken from "Meaning as Adjustment," *Psychological Review*, XV (May, 1908), 169.

B[1]

BY HERBERT SIDNEY LANGFELD

The meaning of an object is our attitude toward that object, our reaction to it. In like manner the meaning of an image is that inevitable change in our organism which follows its appearance in consciousness. This change may consist of immediate motor discharge and accompanying kinaesthetic sensations or in visceral, glandular or similar reactions characteristic of emotional states. In terms of the self we may say that we assume a definite attitude toward the image just as we do toward the object. The image acts for or represents the object and in doing so acts as a cue for a definite reaction belonging to the object. Of all possible purposes of an image certainly that of representing a situation not present to the senses is the most obvious.[2]

This function of representation is not, however, characteristic alone of imagery, but belongs also to sensations aroused by an external stimulus, and cannot therefore be used to distinguish it from the latter. The following illustration makes this point evident. If one comes suddenly upon a white sheet hanging upon a line in the moonlight one will probably inhibit one's mechanism for advancing and at least prepare for retreat. This will be readily recognized as a ghost reaction. The situation means ghost. It may be that our sensations will be supplemented by imagery and that we shall actually perceive a ghost. I am inclined to believe that in many instances if not always the imagery which completes the perception accompanies or follows the reaction rather than precedes it and that the externally produced sensation is the sole cue. When we think ghost it may happen that we shall have not a complete image of a ghost but a fragmentary one of the white sheet. Here the image alone is the cue and as in the case of the perception the reaction, to a large extent emotional, is the ghost meaning.

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[1] Taken from "Concerning the Image," *Psychological Review*, XXIII (1916), 180–82.

[2] Colvin says in "The Learning Process," p. 111: ". . . . the meaning of a situation is after all an attitude, and that attitude must in the last analysis be a motor affair. Thus it is but a step to the conclusion that this general dependence of experience for its significance on motor adjustments had left a deposit or 'mind-stuff' that symbolically represents concrete situations, not actually present, but ideally represented."

Hollingworth writes: "Their place (objects of perception) is taken by any content, revived, perseverative, or immediately sensory in character, which happens to be easily available at the time. These processes, by a sort of substitutional rôle, come to represent and impersonate the object between which the relations, as socially recognized, would be said to hold" ("Vicarious Functioning of Irrelevant Imagery," *J. of Phil.*, 1911, 8, 691).

I have purposely chosen as an illustration an incomplete representation, *i.e.*, the white sheet for the whole ghost. The image may be an almost perfect likeness of an object. In most cases, however, it is not; and often it is so far removed from the original object that to say that it means the object seems on the face of it almost absurd.[1] But from what we know of the laws of association one thing is certain, namely that a hundred different images can introduce almost the same reaction, and if the reaction is the meaning then a hundred different images can in this sense stand for the same meaning, although ninety-nine of them must of necessity be what I should like to call inadequate images, if I may borrow an adjective used in the case of stimuli arousing paradoxical sensations.

EXERCISE

1. Say, aloud, again and again, the word "banana." What happens to the meaning of this word? Look at the printed word "horse" for a prolonged period. Compare this experience with that going with the reiteration of the word "banana."

2. CONCEPTION[2]

BY T. LOVEDAY AND J. A. GREEN

1. What is meant by "Conception."—An old man is digging in a garden. He digs up a worm, picks it up, and mechanically throws it aside. Near him is a robin, who pounces on the worm which has been cast away. You may suppose the gardener's behaviour and the robin's to be very much alike in character; and in the particular instance they may be not very dissimilar, for the gardener may act without thinking, as soon as he sees a worm. But the gardener knows some reason for what he does. He may not have been thinking of it at the moment, but if you inquire, he will say, perhaps, "Did I throw a worm out? Well, it was because they would eat the roots of my young cabbages." The bird does not think about worms: it pecks at them unreflectingly. Experience has taught it that worms are worth pecking at, and bits of stick or straw are not; but it has no views or beliefs about them. The man has beliefs. He can not only perceive a worm and act on what he sees, but he can think about worms in general, even when he does not see them, and act upon what he believes. If he believes, as we have supposed, that worms are injurious, he will act in one way; if he thinks this belief to be a silly superstition, he will act differently. In the one case he is said to affirm, in the other to deny that worms are injurious, and the technical name for the mental operation involved in affirmation and denial is Judging or Judgment.

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[1] I am thinking particularly of the classic example of the image for "but" described by Professor Titchener. The presence of inadequate imagery has been repeatedly mentioned in the literature. In the *Philosophical Review*, 1897, p. 650, J. R. Angell writes: "They (images) often shift, and are by no means the same at different times. Indeed, there is no necessity that they should be, representing as they do simply a medium for the performance of a certain function, *i.e.*, the function of meaning a definite thing. Thus the image which serves me in using the concept 'justice' is sometimes a visual image of a state of justice and sometimes simply the auditory word image" ("Thought and Imagery").

[2] Taken from *An Introduction to Psychology*, pp. 179–91. Oxford: Clarendon Press, 1912.

Instead of judging that worms are or are not injurious, our gardener might ask whether they are, or might say to himself, "Suppose they are, what is the best way of dealing with them?" Questioning and supposing are also ways of thinking, but he could not question or suppose unless he could already judge: judging is the most fundamental and most important way of thinking. Whether he judges, however, or questions, or makes a supposition, in any case it is about worms in general—the common nature of worms—that he thinks. He can perceive only this particular worm or this particular group of worms as they are at the moment that he sees them; but in thinking he liberates himself from the details of the moment, and has for his object, not this particular thing as it is here and now, but what is called a universal object. All thinking involves such apprehension of universals, and "the cognition of a universal as distinguished from the particulars which it unifies is called Conception or Conceiving.

Even in percepts there is a universal element present. Owing to its past experience, worms are now familiar to the bird, so that it recognizes one when it sees it, and reacts the more quickly: and they are familiar because they are alike—i.e., have a common nature in spite of their individual differences, though the bird cannot attend to and think about this common nature by itself. Our perception is generally modified by the fact that we can think: we recognize what we perceive as a tree or a bird or a person—in short, as one of a kind—and can name it: we say "I see a bird," or "I heard a noise." This may be called conceptual perception, because we make the universal element in our percepts more explicit by naming it; but we can name things without necessarily thinking about their universal nature by itself. My eye at this moment catches sight of an object which I recognize and call a postage-stamp. The name which I give to it implies that it is one of an indefinite number of objects which, however much they may differ in appearance, and whatever part of the world they may come from, fulfill a common function in our social life. I need not be thinking about this common function, but I can if I will; if I do, I conceive it, and it is my concept—a universal character, common to all particular postage-stamps.

But, you may say, I can think not only about birds or trees or postage-stamps in general; I can equally well think about individual objects. This postage-stamp, for example—I can wonder why it is triangular and judge that it is foreign and many years old. That is so: we can think not only about kinds and their common character, but also about individual things and persons. Indeed, we shall find that the first objects of the child's first attempts at conception are probably individuals. What is not so obvious, perhaps, is that these individual concepts are also universals. Yet when I think about *this* postage-stamp, it is not simply the object of a moment's vision that I think about; I conceive it as a thing having a history: it was made so many years ago, was posted and travelled, and now is exhibited in an album, and yet is one identical thing through all its changes. When I think about postage-stamps in general, I conceive the common character which is identical in all of them that are or have been or will be; when I think of this postage-stamp, I conceive it as being an identical thing as long as it exists as a postage-stamp. In both cases I think of what goes beyond the moment and is universal. Sometimes the persistent identity of an individual is so important that it has a proper name. You do not think of your dog merely as "dog," nor are you content to call him "my dog": you name him "Carlo." Think again what a wealth of meaning there is for any one in the words "my mother." You may think of her in so many circumstances, occupied in so many ways, tending you with encouragement or reproof or consolation, and yet one identical person throughout. All thinking therefore involves conception, and even individual concepts are universals.

There are indeed important differences between individual concepts and other universals, but for a treatment of them the reader is referred to works upon Logic. Nor is there any need to attempt here a list of the various kinds of concepts. It may be worth while to point out, however, that one's dog, for example, not only has those characters which are common to all dogs and make him a dog and not (say) a cat, but is also (let us suppose) big, black, affectionate, and trustworthy, came from such and such a place, and is now just three years old. He has in fact an indefinite number of qualities, and stands in an indefinite number of relations to other things; and he is a unique object because he alone has just this union of qualities and stands in just these relations. Now we can think about these qualities in him and his relations—his blackness, his age and the rest: or we can think about blackness or colour, or affection or goodness, or age or time, and so on, in general. All these objects of thought, then, are concepts.

Some writers have laid great emphasis on the fact that the most prominent element in many of our general concepts is the practical use that we would make of things, or the practical attitude that we should adopt towards them. A knife is "a thing to cut with," a spoon "a thing to eat with," a chair "a thing to sit upon," a house "a thing to live in." Children and uneducated people are apt to define most things by their practical use, and not only such instruments and contrivances as a spoon or a chair, just as all of us who are not zoölogists think of a horse primarily as a creature to ride or drive, because it is the use of the horse to us that interests us, and not its zoölogical characters and relationships. But we must not exaggerate the importance of such "practical" meaning. It is true, of course, that your knowledge of a tiger is very inadequate if "you believe that when you meet one you pat him on the head and ask him to give you his paw"; but it would be quite as inadequate if you thought of him simply as a powerful beast to be avoided; and in many of our concepts—e.g. psychology, poetry, religion, possibility, society, policy—the "practical" element, if not altogether absent, is at least subordinate.

2. The Development of Conception.—The child passes from the perceptual to the conceptual stage of intelligence by a gradual development, and so we must not suppose that when it begins to think, it thinks just as we do, any more than when it begins to speak, it can speak just as we do. Its first thoughts will be only a little advance upon perception, and we who have forgotten that transitional period can hardly hope to know what it is like. Nor can we tell exactly when the child begins to think. In infancy he learns to use words, and words are for us the socially accepted signs of thoughts. We may, therefore, learn something from the child's use of words, at any rate if we attend to the tone of his voice and his general attitude in using them. For his first true words (as distinct from earlier noises of emotional excitement) are got by imitation: they are simply imitative reactions on the sight of particular things in particular settings—percept-words, we have called them—involving recognition of a kind, no doubt, but not yet anything that deserves to be called judgment. Sometimes, too, when we might be inclined to fancy that the child is judging, he is merely showing off. Yet probably he begins to judge in some poor way sooner than we often suppose. Before he has got to putting words together ("Tummled baby" on a fall, "Bing shut" when the door is closed, or the like), we sometimes notice an affirmative tone in his use of names of familiar objects or persons—"tic-tac" of the nursery clock, "mama," "dada—a tone which seems to correspond to ours when we say "There is So-and-so." Like us, the child adopts this tone when he recognizes under difficulties—when the clock is out of its usual position, or his mother has on a different hat; and it seems to indicate an elementary affirmation that this is the same thing or the same person in spite of its differences. Conception is here still inbound with perception; but soon the child, faced by other troublesome situations, begins to notice that his mother has gone and to anticipate her return, thus passing away from perception to evident thought.

The first objects at all clearly conceived are individual persons and things. But conceiving one thing clearly involves distinguishing it from others, and there is a previous stage in which the child's tendency is, perhaps, more evidently to note similarities than to make distinctions. A child of eighteen months calls his father's match-box a "tic-tac," because both watch and match-box are drawn from the waistcoat-pocket. Earlier than that he has called other timepieces besides the nursery clock by that name, and earlier still he has called all friendly men "dada." The fact is that conceptions both of individuals and of kinds of things and their common nature develop out of the same stage of vague, indefinite apprehension, which is a little more than bare perception, and a good deal less than thought. Individual concepts become clear first: the child thinks about the nursery clock before he thinks about clocks; but he can recognize clocks and give them a common name before he can think about the nursery clock. The common name is called forth by some common perceptual feature, and not by any cognition of a universal apart from the perceptual experiences which it unifies. He recognizes similar qualities in different objects of perception, but does not yet think of them as similar. Yet this recognition of them already involves a rudimentary form of that mental analysis and synthesis which will afterwards become deliberate comparison: attention is concentrated on this or that feature of a percept (say the look of a clock's dial) which is thus analysed, and by the recognition of a similar feature in another clock the new experience is (though vaguely) united to the old.

So the percept-word "tic-tac" is soon applied to many clocks besides the nursery clock because of some similarity in appearance. Then the child's attention may be directed to the sound, and he learns to call his father's watch by the same name. But his course is tortuous, for he may, as we saw, call a pocket-match-box "tic-tac," until the difference is pointed out to him; and at first the difference insisted on is just the difference of name, for he would not understand if we said that one tells us the time and the other holds matches. (Many early distinctions are forced on the child at first as differences of names. He calls a hen "quack-quack," only to be pulled up by his nurse: "No, baby, not a 'quack-quack'—a 'chuck-chuck'"—and thus he is induced to notice other differences. Helped by words, a young child learns with astonishing rapidity to distinguish kittens from puppies, cocks from hens, girls from boys, in real life or in his picture-books.) So far to return to clocks—the child has not begun to think about clocks and watches in general, and when he does, they probably are to him curious-looking things that he expects to see on any mantelpiece or find in any waistcoat-pocket. He is still far from any notion of time, and it is not till months after he has grasped the meaning of "Yesterday" and "To-morrow" that he learns to use a clock himself, though he gradually discovers that it tells others when dinner is ready or it is what they call his bed-time. By now he speaks of a clock, has seen clocks wound up and has peeped into their works. Moreover, he has toys that move when they are wound up; he hears them called clock-work toys, and anyhow he probably notices a likeness between winding them and winding the clock. So another move forward is possible, that may not be completed for years, but ends in his understanding the connexion—the tightly wound spring as the driving force common to clock and watch and toy.

Each step in his progress has been marked by a new discovery about the nature of the object itself, the result of a deeper analysis, which has been prompted now by his own curiosity, now by the directions of others, and now by casual experience; and each deeper analysis has led to wider synthesis, so that his concept is richer and fuller than before, since he has brought the clock into new relationships,—first with the watch, then perhaps with watch and sundial as time-keepers, then with watch and toys as mechanisms.

He may go farther. The tall clock in the hall has no springs, but weights, and this is a puzzle which incites to new analysis. The tall clock stops when these weights reach the ground just as little clocks stop when the spring is slack. Thus he is led to think of and inquire about other ways in which driving power may be obtained and used; and so—much later, probably—he learns to think of energy in general, and with that thought gets a new view of the water stored in the dams, the steam in the engine-boiler, the tides, the sun itself. Again a new synthesis follows on deeper analysis. It will be noted in this example how dependent the development of conceptual knowledge is upon actual acquaintance with particular clocks and watches and toys and the rest, when a child begins to think about any kind of thing, his concepts are necessarily coloured by the specimens that he has met. If he has been acquainted only with small dogs, his concept "dog" will be different from that of another boy who has seen large dogs as well; if he has romped with dogs, it will be different from that of a boy who has been taught to be too cautious. Words are deceiving: the child learns words before he learns their accepted sense. He may recognize all the ships in his books, and talk and think about them, and yet know practically nothing about real ships, if he has never seen one. Of course his thoughts do not depend wholly on what he has himself perceived, for directly and indirectly he picks up information from others; but if we go far ahead of his life's experience, our words have no meaning for him, or have a meaning very unlike to what we intend. Children's facility in picking up words is a common pitfall for the unwary teacher who ignores the slow growth of thought and mistakes the apt use of words for real knowledge.

This personal colouring adheres more or less to the thoughts of all of us, and so to the values of the words we use. The fact that two persons use the same word does not necessarily imply that their thought is wholly identical, though it must be partially so if they are to converse at all. Many controversies have arisen from the disputant's failure to discover the precise sense in which the same words are used on either side, and have lapsed when this has been discovered. It is a good rule in discussion, as in scientific exposition, to begin by saying explicitly what the more important of the terms to be used mean, even though their meaning may subsequently need to be revised; but for a full treatment of this matter we must again refer to the textbooks on Logic and their account of logical definition. In ordinary life we are generally satisfied with an approximation towards identity in our thoughts and use of words; we classify our meaning and rid it of personal colouring just so far as the need for intercourse and communication with other people compels us to do so. The fisherman and the fishmonger and the cook do not all think of fish in just the same way, but nearly enough in the same way to be able to understand and deal with one another, though none of them knows the zoölogist's definition of "fish."

But our thoughts do not merely depend upon our perceptual experience; they also react upon it. We have already seen how they give meaning to our percepts which are now conceptually recognized; but, more than this, they guide our observation, and so enable us to notice much that we should otherwise have neglected. The botanist and the geologist and the artist each see much that the other misses in the same country scene; and even to Peter Bell "a primrose by the river's brim" will be more than merely a yellow primrose, if you can get him to pull it to pieces under your direction and to compare its parts with those of other common flowers, and so to become interested in and think about floral structure. He will then be able to note many differences, previously neglected, between similar-looking flowers, such as buttercup and silverweed, and many common characters in others, such as honeysuckle and elder, which are closely related in spite of their different appearance.

Similarly an engineer, because he can find order and meaning in what is a mere medley of moving parts to the man without knowledge of machines, is better able to guide his observation in a laboratory or workshop. His knowledge teaches him what to look for, and how and where to look for it.

EXERCISES

1. What are the elements in the conception of "John" that are present for practically everybody who understands the word at all?
2. What are some of the elements in your own particular conception of "John"?
3. Write a short sketch of the development of your present conception of psychology.

3. CONCEPTION AND LANGUAGE[1]

BY HARALD HÖFFDING

The primitive cognitive functions, sensation and perception, do not require the definite symbols of language. The memory-image, if not perfectly fresh and vivid, may, however, be in need of the name.

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[1] Taken by permission from *Outlines of Psychology*, pp. 172–73. (Translated by Mary E. Lowndes.) New York: Macmillan & Co. Copyrighted, 1891.

The more the memory and the idea renew the reality for us and approximate to intuition, the more they are independent of the word. But with more faded and especially with typical and general ideas, the word is an essential help. With some people thought is an inner speech to the extent that intense thought makes them hoarse. For this reason thought has been called "a process of speech imperceptibly carried on in the central parts," which stands in the same relation to actual speaking as the will to actual movement. This is especially the case with persons whose ideas of words consist mainly of motor-representations. With other persons ideas of words are mainly auditory or visual ideas, *i.e.*, they are reproductions of words as seen or heard. Still there seems to be with everybody an innervation, more or less strong, of the articulatory muscles in every representation of a word.

In the general idea the word is of especial importance. For here there is no longer anything which can be intuited, and even the need for something to intuit introduces a danger, for it may lead to the confounding of the typical with the individual. Only by means of the name can the clear and firm nucleus escape confusion with its obscure and changing surroundings. The name is, as it were, a substitute for the impossible intuition, and by misuse it may even take the place of the general idea.

The deaf and dumb, even if they have not learnt to talk on their fingers, describe objects and experiences in the liveliest and most individual way by gestures and imitative movements. But this very individuality and concreteness of their expressions makes it impossible for them to form clear and definite general ideas; these do not get properly disjoined from individual ideas. Thus they indicate meat and food by pointing to their own body, red by touching the lips. They can express the special way in which a thing is made (a wall built, a dress cut out, etc.), but not the general idea of making. This is why the want of hearing and speech so greatly interferes with mental development.

EXERCISE

1. Why is an individual whose conception of length is symbolized by a visual image of the long side of a block of wood less likely to employ that concept accurately than one whose conception of length is symbolized by the word "length"?

4. REASONING

A. The Rational and Motor Methods of Solution[1]

BY HARVEY A. CARR

For the purpose of a preliminary analysis, reasoning may be contrasted with the motor method of learning, since a human being may employ either method in the solution of a sensory problem. A dog, attempting to get through a fence without dropping a cane that it carried in its mouth, finally discovered the solution of the problem by trying out in a random and unsystematic manner all those responses which in times past had proven efficacious in dealing with similar situations. Let us suppose that the dog can think, or better let us imagine that a human being, endowed with the dog's equipment, is confronted with that situation and attempts to solve it by means of reason. The dog reacts to the situation, experiences the sensory consequences of the act, and modifies his behavior in terms of these consequences. In other words, the dog discovers the adaptive relation of any act to the objective situation by performing that act and sensing its results. In reasoning, our hypothetical subject refrains from acting, and imagines what will probably happen provided he should perform a given act. The subject thus ideationally apprehends an act in its adaptive relation to the objective situation and modifies his subsequent procedure in terms of this knowledge. One ideational attempt will suggest another until the subject happens to think of an act which is deemed appropriate, and this thought will then arouse the act in question. The thought of an act will arouse that act only when such behavior is regarded as relevant to the situation of the moment. In performing the act, the subject may discover that his judgment of its adaptive character was erroneous, and the quest for a solution is then continued until the subject discovers an act which he believes to be appropriate and this belief is verified by the successful performance of that act.

One may likewise compare the two methods as applied to the solution of a manipulative puzzle. With the motor method, the subject twists and pulls and manipulates the apparatus in a hit and miss fashion and perceptually notes the consequences of each attempt. When reason is employed, the subject refrains from acting, perceptually analyzes the situation, and thinks of what will happen in case he should act in a given way. The solution is discovered by means of movements in the one case and by means of ideas in the other.

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[1] Adapted from the manuscript of a textbook in psychology.

The two methods of adjustment are identical in most respects. Both involve a motivating problematical situation, a variable, unsystematic and analytical mode of attack which is continued until the solution is more or less accidentally discovered, and a series of repeated trials to perfect and fixate the correct response. In both cases the problem is solved in terms of previous experiences acquired in dealing with similar situations. The motor method involves a series of overt responses to a perceptual situation, while reasoning is primarily characterized by the fact that it employs ideas as substitutes for or representatives of those movements or percepts. In the simpler types of reasoning, as in the illustrations already cited, the subject utilizes ideas as substitutes for the movements, i.e., he thinks of these movements instead of performing them. In the higher types of rational process both the objective situation and the series of responses are ideationally represented, and the whole process of adjustment is mediated in terms of ideas. Obviously the possession of ideas and the ability to reason are correlated phenomena.

B. Reasoning[1]

BY T. LOVEDAY AND J. A. GREEN

Reasoning is the way of finding an answer that is not obvious to questions that the mind sets to itself. We cannot indicate the moment in a child's life when reasoning begins, any more than that when judgment begins, for the development is continuous and not by jumps; but we can indicate the practical attitude which is the prototype of reasoning, and out of which explicit reasoning may grow. A child of eighteen months has been used to play with a ball on the lawn. When she goes out and finds no ball there, she usually seems disappointed, calls "Ba," perhaps frets or cries. One day she runs into the house, goes to the drawer in which the ball is kept, and tries to open it. Here is an adaptation of means to an end, not indeed the first in her life, but sufficiently complicated to arrest our attention. We need not suppose that it involves explicit reasoning—the child has no speech beyond a few substantives; thought is still merged in action, and the problem *How?* is solved at the level of action. Similarly, elder persons may put together jig-saw puzzles, manipulate instruments and alter them to suit varying purposes—a carpenter's plane, for instance—splice and whip a broken rod, and solve other practical problems without reflection on the ways of doing so. But we find in our own experience that often the question *How?* can be answered only by taking thought, or at any rate that taking thought saves us a great deal of trouble and many failures; and then we make plans, as e.g., for a journey. How are we to get to our destination? We must discover what line runs there, and when the trains start and arrive: we must get a time-table: we find that we must order a cab at such an hour: finally we summon one by the telephone. The problem may become more complicated if there are two lines running there: we have to estimate their rival advantages, perhaps we have to re-state our purpose to ourselves more clearly and decide on the most convenient hour of arrival; but in general our procedure is to work back from the end in view through thought of the means necessary to its accomplishment till we arrive at a practical step which we take. The practical problems which the child first tries to solve by thought are, of course, far simpler than this: how to get at sweets in a high cupboard, how to hide successfully in a game of hide-and-seek, or the like; but they are the same in type. Some end is desired which cannot be attained immediately, and it is connected with what can be done at once by thought of various means. The means that first suggest themselves to the child may seem to us absurd, owing to the child's lack of experience; but its thought is not for that reason irrelevant, even when futile.

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[1] Taken from *An Introduction to Psychology*, pp. 214–22. Oxford: Clarendon Press, 1912.

But *How?* is not the only question that the child asks itself (and others): still more frequent, because less easily answered by direct action, is the question *Why?* Like *How?* it originates in some surprise or bewilderment, but it is a more speculative question and involves a stirring of curiosity to know. It is not asked till late in the third year, as a rule, and comes after the questions *Where?* and *What?* and *Who?* The child's mother is not to be found at the usual place and time: Where is she? then later, Why is she not here? Some implement or article of furniture is seen for the first time, or a novel object in a shop-window. What is it? (and this at first means, What is it for? What is its use?); then later, Why has it that shape or colour? A particularly common form of *Why?* is, Who made so-and-so? First of all, Who made something be or behave in an unexpected way? (e.g., Who made the cup broken, or the cat frightened); then, in the sense of Who was the maker of the flowers or the cat or the house? The child's first questions are about particular persons or things that he sees or expects to see; and the answers he wants are in terms of use and agency. But when there is no one to answer, the child has to think for himself. Here, again, the problem is one of connexion: the observed fact has to be connected with what is already known. The connexions that occur to the child may seem very absurd to us, but for all that they may be the result of very relevant thinking. Dr. Sully tells of a "little zoölogist" who wanted to know whether Pussy hatched out kittens by sitting on eggs. The suggestion is really very much to the point, if we consider the child's limited experience. It is based upon resemblance—the similar case of little chickens,—and logically no doubt it involves a generalization from chickens to all young animals; but we must not suppose that the child actually thought in this way: "Little chickens are hatched from eggs, ∴ all little animals are, ∴ kittens are." The universal judgment about "all little animals" is logically implied, but it is not actually thought.

In this case the child, wiser than his elders often are, did not commit himself to a conclusion, but suspended judgment and inquired whether his guess were true. If now we turn to more advanced attempts at explanation, we find that in type the process remains the same. Something of which the reason is not known has to be connected with what we do know, and we connect it by a guess (now perhaps called an "hypothesis"). Suppose that as you lie in bed one morning a horse comes ridden past. You recognize the source of the noise at once, and say "I hear a horse coming down the road." Strictly speaking, you do not hear the horse, but only the noise: yet you recognize the cause of the noise so quickly that you never ask yourself what the cause is. Psychologically we cannot say that there is inference in such rapid conceptual recognition, though you may be mistaken—(e.g., you may say that you "hear a cuckoo," when really it is a boy imitating the cuckoo), and if your statement were challenged, you would have to give reasons for it. But a few minutes later you hear another noise, which is less familiar. You make guesses. Is it a motor-bicycle? or a threshing-machine? But it is not exactly like the sound of either, and, besides, it does not seem to come from the road. You have heard that aeroplanes make a queer noise of this kind. Perhaps it is an aeroplane. Then you test your hypothesis by looking out of the window or inquiring of some one else, and make sure that an aeroplane has gone by.

In this instance we may notice four points. You are not content to leave the problem just as it first occurred to you, but you try to render it more precise: first it was just a noise that puzzled you, then a very peculiar noise, then a very peculiar noise coming from an unusual direction. Thus you reduce the number of likely guesses. But, secondly, you are able to make likely guesses only because of the extent of your previous knowledge. If you had always lived in a town, you would not know the noise of a threshing-machine; if you had never learned anything about aeroplanes, it would not occur to you that this horrible noise might be due to one. Yet, thirdly, a slower mind might know as much as you about aeroplanes, and yet not think of them in this connexion: so that knowledge must be combined with a certain quickness of thought in a good guesser. And, lastly, you suspend judgment until you can verify your guess.

Suppose you feel ill and call in your doctor. Yours may be a simple case: he knows that these symptoms can mean only one thing, and he tells you at once what is the matter with you. But the cause of the trouble may be more obscure. He then proceeds to define the problem, by feeling your pulse, looking at your tongue watching you for symptoms that escape the first glance. If he has experience and knowledge and is also sufficiently quick of mind, several possible explanations may occur to him. But if he is duly cautious, he waits before pronouncing judgment. Suppose so-and-so is the cause, he would expect certain further symptoms, which he has not yet looked for: now he looks for them, perhaps has to wait a day or two to see whether they appear, and so tests his hypotheses by observation.

Sometimes he may be able to recognize symptoms as meaning a certain disease, but still not understand the nature of the disease, nor how it originated. The attempt at explanation has to be carried further back, and by the same means—guessing, and testing the guesses by observation and, when possible, by experiment.

A great many popular beliefs are explanations which have been handed down from generation to generation without being adequately tested. Thus the belief that the sun goes round the earth accounted for a number of observed facts, but those which it makes unintelligible were not noticed. Men jumped to a conclusion. Similarly, it was until recently believed, naturally enough, that malaria is caught by inhaling the vapours that rise from marshy land. This belief accounted for the frequency of the disease in marshy country and its disappearance when the marshes are drained. But there were all the time facts, unnoticed or unconsidered, for which it did not account; and it has now been discovered that the minute organism which causes the disease is conveyed by a mosquito, so that if one is protected from mosquitoes' bites, one can stay in malarial country without catching malaria.

To be able to see where problems lie, and to be fertile of guesses in explanation of them, are powers which different minds possess in different degrees. Something may, no doubt, be done to train the former power so that curiosity becomes well directed. It is doubtful, however, whether education can do much to improve quickness at making guesses. Increase of knowledge may help out a natural weakness, perhaps, as far as a particular topic is concerned, but it does not necessarily effect a general improvement. Thus we often wonder equally at the appropriateness of the guesses which a specialist makes in his own subject, and at his childishness when he passes outside of it. Perhaps the truth is that knowledge improves the quality of a man's guesses, but not his fertility of guesses. However that may be, it is at least important that education should not still these powers, as it is apt to do when it becomes too formal or is degraded into the mere imparting of information.

When we start with the question *Why?* we can preface our answer with the word *Because*. But sometimes we start from a general principle, instead of searching for one, and apply it in a special instance. Examples are hardly necessary, so familiar are arguments of this type. "Late letters need an extra stamp: you must put one on;" "You had better avoid that mountain because it's dangerous without a guide"; "I'd rather not join in because one bad player spoils the set," or any applications of proverbs or rules, may serve as illustrations. It has to be noticed, however, here as before, that we may argue in a way which logically implies a general principle, without actually attending to the principle in thought. One child says to another, "You must come in now." "Why?" "Because you must": he is puzzled when asked to state the reason. A little later he will say, "Because mamma is calling you," but still he does not think clearly of the general principle that she must be obeyed, though perhaps he might say so in other words if he were still met by refusal. Similarly we argue, "He talks like a Yorkshireman"; "It is so foggy that the train will be late"; "Since we have to take the work on, we had better make the best of it"; "He must have been at home, because I got a reply by return," and the like, without ever formulating the general principles on which our arguments depend.

In small children two kinds of conditions seem to be especially stimulating to reasoning of this type. One is expectation of some very gratifying or unpleasant occurrence—e.g., "To-morrow is Sunday, so I shall have tart for dinner"; the other, any shock to the child's ideas of right or any opportunity of imposing a moral principle on others, e.g., "You mustn't do that, because it's naughty," or the example in the last paragraph. It is, perhaps, in connexion with commands or persuasions that he most often hears the word "because" and first comes to understand its meaning: "You must put up your toys now, because it's bed-time"; "Don't make a noise, because you'll wake up the baby," and other such reasonable admonitions are constantly impressed upon him. Similarly, he would never learn to ask "Why?" and "How?", unless he were often told how to do things and asked why he is doing this or that. Very slowly he learns to understand these questions, first putting them to others and then to himself.

C. The Steps in Reasoning[1]

BY JOHN DEWEY

We shall make an analysis of the process of thinking into its steps or elementary constituents, basing the analysis upon descriptions of a number of extremely simple, but genuine, cases of reflective experience.

1. "The other day when I was down town on 16th Street a clock caught my eye. I saw that the hands pointed to 12:30. This suggested that I had an engagement at 124th Street, at one o'clock. I reasoned that as it had taken me an hour to come down on a surface car, I should probably be twenty minutes late if I returned the same way. I might save twenty minutes by a subway express. But was there a station near? If not, I might lose more than twenty minutes in looking for one. Then I thought of the elevated, and I saw there was such a line within two blocks. But where was the station? If it were several blocks above or below the street I was on, I should lose time instead of gaining it. My mind went back to the subway express as quicker than the elevated; furthermore, I remembered that it went nearer than the elevated to the part of 124th Street I wished to reach, so that time would be saved at the end of the journey. I concluded in favor of the subway, and reached my destination by one o'clock."

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[1] Adapted from *How We Think*, pp. 68–78. New York: D. C. Heath & Co., 1910.

2. "Projecting nearly horizontally from the upper deck of the ferryboat on which I daily cross the river, is a long white pole, bearing a gilded ball at its tip. It suggested a flagpole when I first saw it; its color, shape, and gilded ball agreed with this idea, and these reasons seemed to justify me in this belief. But soon difficulties presented themselves. The pole was nearly horizontal, an unusual position for a flagpole; in the next place, there was no pulley, ring, or cord by which to attach a flag; finally, there were elsewhere two vertical staffs from which flags were occasionally flown. It seemed probable that the pole was not there for flag-flying.

"I then tried to imagine all possible purposes of such a pole, and to consider for which of these it was best suited: (*a*) Possibly it was an ornament. But as all the ferryboats and even the tugboats carried like poles, this hypothesis was rejected. (*b*) Possibly it was the terminal of a wireless telegraph. But the same considerations made this improbable. Besides, the more natural place for such a terminal would be the highest part of the boat, on top of the pilot house. (*c*) Its purpose might be to point out the direction in which the boat is moving.

"In support of this conclusion, I discovered that the pole was lower than the pilot house, so that the steersman could easily see it. Moreover, the tip was enough higher than the base, so that, from the pilot's position, it must appear to project far out in front of the boat. Moreover, the pilot being near the front of the boat, he would need some such guide as to its direction. Tugboats would also need poles for such a purpose. This hypothesis was so much more probable than the others that I accepted it. I formed the conclusion that the pole was set up for the purpose of showing the pilot the direction in which the boat pointed, to enable him to steer correctly."

3. "In washing tumblers in hot soapsuds and placing them mouth downward on a plate, bubbles appeared on the outside of the mouth of the tumblers and then went inside. Why? The presence of bubbles suggests air, which I note must come from inside the tumbler. I see that the soapy water on the plate prevents escape of the air save as it may be caught in bubbles. But why should air leave the tumbler? There was no substance entering to force it out. It must have expanded. It expands by increase of heat or by decrease of pressure, or by both. Could the air have become heated after the tumbler was taken from the hot suds? Clearly not the air that was already entangled in the water. If heated air was the cause, cold air must have entered in transferring the tumblers from the suds to the plate. I test to see if this supposition is true by taking several more tumblers

out. Some I shake so as to make sure of entrapping cold air in them. Some I take out holding mouth downward in order to prevent cold air from entering. Bubbles appear on the outside of every one of the former and on none of the latter. I must be right in my reference. Air from the outside must have been expanded by the heat of the tumbler, which explains the appearance of the bubbles on the outside.

"But why do they then go inside? Cold contracts. The tumbler cooled and also the air inside it. Tension was removed, and hence bubbles appeared inside. To be sure of this, I test by placing a cup of ice on the tumbler while the bubbles are still forming outside. They soon reverse."

These three cases have been purposely selected so as to form a series from the more rudimentary to more complicated cases of reflection. The first illustrates the kind of thinking done by every one during the day's business, in which neither the data, nor the ways of dealing with them, take one outside the limits of everyday experience. The last furnishes a case in which neither problem nor mode of solution would have been likely to occur except to one with some prior scientific training. The second case forms a natural transition; its materials lie well within the bounds of everyday, unspecialized experience; but the problem, instead of being directly involved in the person's business, arises indirectly out of his activity, and accordingly appeals to a somewhat theoretic and impartial interest.

Upon examination, each instance reveals, more or less clearly, five logically distinct steps: (*i*) a felt difficulty; (*ii*) its location and definition; (*iii*) suggestion of possible solution; (*iv*) development by reasoning of the bearings of the suggestion; (*v*) further observation and experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief.

1. The first and second steps frequently fuse into one. The difficulty may be felt with sufficient definiteness as to set the mind at once speculating upon its probable solution, or an undefined uneasiness and shock may come first, leading only later to definite attempt to find out what is the matter. Whether the two steps are distinct or blended, there is the factor emphasized in our original account of reflection — *viz.*, the perplexity or problem. In the first of the three cases cited, the difficulty resides in the conflict between conditions at hand and a desired and intended result, between an end and the means for teaching it. The purpose of keeping an engagement at a certain time, and the existing hour taken in connection with the location, are not congruous. The object of thinking is to introduce congruity between the two.

The given conditions cannot themselves be altered; time will not go backward nor will the distance between 16th Street and 124th Street shorten itself. The problem is *the discovery of intervening terms which when inserted between the remoter end and the given means will harmonize them with each other.*

In the second case, the difficulty experienced is the incompatibility of a suggested and (temporarily) accepted belief that the pole is a flagpole, with certain other facts. Suppose we symbolize the qualities that suggest *flagpole* by the letters *a*, *b*, *c;* those that oppose this suggestion by the letters *p*, *q*, *r*. There is, of course, nothing inconsistent in the qualities themselves; but in pulling the mind to different and incongruous conclusions they conflict—hence the problem. Here the object is the discovery of some object (*o*), of which *a*, *b*, *c*, and *p*, *q*, *r*, may all be appropriate traits—just as, in our first case, it is to discover a course of action which will combine existing conditions and a remoter result in a single whole. The method of solution is also the same: discovery of intermediate qualities (the position of the pilot house, of the pole, the need of an index to the boat's direction) symbolized by *d*, *g*, *l*, *o*, which bind together otherwise incompatible traits.

In the third case, an observer trained to the idea of natural laws or uniformities finds something odd or exceptional in the behavior of the bubbles. The problem is to reduce the apparent anomalies to instances of well-established laws. Here the method of solution is also to seek for intermediary terms which will connect, by regular linkage, the seemingly extraordinary movements of the bubbles with the conditions known to follow from processes supposed to be operative.

2. As already noted, the first two steps, the feeling of a discrepancy, or difficulty, and the acts of observation that serve to define the character of the difficulty may, in a given instance, telescope together. In cases of striking novelty or unusual perplexity, the difficulty, however, is likely to present itself at first as a shock, as emotional disturbance, as a more or less vague feeling of the unexpected, of something queer, strange, funny, or disconcerting. In such instances, there are necessary observations deliberately calculated to bring to light just what is the trouble, or to make clear the specific character of the problem. In large measure, the existence or non-existence of this step makes the difference between reflection proper, or safeguarded *critical* inference and uncontrolled thinking. Where sufficient pains to locate the difficulty are not taken, suggestions for its resolution must be more or less random. Imagine a doctor called in to prescribe for a patient.

The patient tells him some things that are wrong; his experienced eye, at a glance, takes in other signs of a certain disease. But if he permits the suggestion of this special disease to take possession prematurely of his mind, to become an accepted conclusion, his scientific thinking is by that much cut short. A large part of his technique, as a skilled practitioner, is to prevent the acceptance of the first suggestions that arise; even, indeed, to postpone the occurrence of any very definite suggestion till the trouble—the nature of the problem—has been thoroughly explored. In the case of a physician this proceeding is known as diagnosis, but a similar inspection is required in every novel and complicated situation to prevent rushing to a conclusion. The essence of critical thinking is suspended judgment; and the essence of this suspense is inquiry to determine the nature of the problem before proceeding to attempts at its solution. This, more than any other thing, transforms mere inference into tested inference, suggested conclusions into proof.

3. The third factor is suggestion. The situation in which the perplexity occurs calls up something not present to the senses: the present location, the thought of subway or elevated train; the stick before the eyes, the idea of a flagpole, an ornament, an apparatus for wireless telegraphy; the soap bubbles, the law of expansion of bodies through heat and of their contraction through cold. (*a*) Suggestion is the very heart of inference; it involves going from what is present to something absent. Hence, it is more or less speculative, adventurous. Since inference goes beyond what is actually present, it involves a leap, a jump, the propriety of which cannot be absolutely warranted in advance, no matter what precautions be taken. Its control is indirect, on the one hand, involving the formation of habits of mind which are at once enterprising and cautious; and on the other hand, involving the selection and arrangement of the particular facts upon perception of which suggestion issues. (*b*) The suggested conclusion so far as it is not accepted but only tentatively entertained constitutes an idea. Synonyms for this are *supposition*, *conjecture*, *guess*, *hypothesis*, and (in elaborate cases) *theory*. Since suspended belief, or the postponement of a final conclusion pending further evidence, depends partly upon the presence of rival conjectures as to the best course to pursue or the probable explanation to favor, *cultivation of a variety of alternative suggestions* is an important factor in good thinking.

4. The process of developing the bearings—or, as they are more technically termed, the *implications*—of any idea with respect to any

problem, is termed *reasoning.* As an idea is inferred from given facts, so reasoning sets out from an idea. The *idea* of elevated road is developed into the idea of difficulty of locating station, length of time occupied on the journey, distance of station at the other end from place to be reached. In the second case, the implication of a flagpole is seen to be a vertical position; of a wireless apparatus, location on a high part of the ship and, moreover, absence from every casual tugboat; while the idea of index to direction in which the boat moves, when developed, is found to cover all the details of the case.

Reasoning has the same effect upon a suggested solution as more intimate and extensive observation has upon the original problem. Acceptance of the suggestion in its first form is prevented by looking into it more thoroughly. Conjectures that seem plausible at first sight are often found unfit or even absurd when their full consequences are traced out. Even when reasoning out the bearings of a supposition does not lead to rejection, it develops the idea into a form in which it is more apposite to the problem. Only when, for example, the conjecture that a pole was an index-pole had been thought out into its bearings could its particular applicability to the case in hand be judged. Suggestions at first seemingly remote and wild are frequently so transformed by being elaborated into what follows from them as to become apt and fruitful. The development of an idea through reasoning helps at least to supply the intervening or intermediate terms that link together into a consistent whole apparently discrepant extremes.

5. The concluding and conclusive step is some kind of *experimental corroboration*, or verification, of the conjectural idea. Reasoning shows that *if* the idea be adopted, certain consequences follow. So far the conclusion is hypothetical or conditional. If we look and find present all the conditions demanded by the theory, and if we find the characteristic traits called for by rival alternatives to be lacking, the tendency to believe, to accept, is almost irresistible. Sometimes direct observation furnishes corroboration, as in the case of the pole on the boat. In other cases, as in that of the bubbles, experiment is required; that is, *conditions are deliberately arranged in accord with the requirements of an idea or hypothesis to see if the results theoretically indicated by the idea actually occur.* If it is found that the experimental results agree with the theoretical, or rationally deduced, results, and if there is reason to believe that *only* the conditions in question would yield such results, the confirmation is so strong as to induce a conclusion—at least until contrary facts shall indicate the advisability of its revision.

Observation exists at the beginning and again at the end of the process: at the beginning, to determine more definitely and precisely the nature of the difficulty to be dealt with; at the end, to test the value of some hypothetically entertained conclusion. Between those two termini of observation, we find the more distinctively *mental* aspects of the entire thought-cycle: (*i*) inference, the suggestion of an explanation or solution; and (*ii*) reasoning, the development of the bearings and implications of the suggestion. Reasoning requires some experimental observation to confirm it, while experiment can be economically and fruitfully conducted only on the basis of an idea that has been tentatively developed by reasoning.

The disciplined, or logically trained, mind—the aim of the educative process—is the mind able to judge how far each of these steps needs to be carried in any particular situation. No cast-iron rules can be laid down. Each case has to be dealt with as it arises, on the basis of its importance and of the context in which it occurs. To take too much pains in one case is as foolish—as illogical—as to take too little in another. At one extreme, almost any conclusion that insures prompt and unified action may be better than any long delayed conclusion; while at the other, decision may have to be postponed for a long period—perhaps for a life-time. The trained mind is the one that best grasps the degree of observation, forming of ideas, reasoning, and experimental testing required in any special case, and that profits the most, in future thinking, by mistakes made in the past. What is important is that the mind should be sensitive to problems and skilled in methods of attack and solution.

D. Puzzle-Solving[1]

BY HENRY ALFRED RUGER

a). *Accident and Analysis.*—In general, the solutions were not the result of mere straightaway thinking and the consequent formulation of a thoroughgoing plan of action, but were the outcome of an extremely complex interrelation of more or less random impulses and of ideas.

In a number of cases the solution came entirely by accident as far as the essential movement was concerned, but, even then, there was usually some awareness of the general position just before or just after the successful movement. Thus, in one case of a purely accidental success a vivid visual impression of the final position was obtained, and the solution later flashed upon the subject by means of an involuntary analysis of the resulting image. In most cases of accidental success, however, instead of a precise analysis there resulted at first merely a limitation of the problem center to the general region or kind of movement connected with the solution.

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[1] Adapted from *The Psychology of Efficiency*, "Columbia Contributions to Philosophy and Psychology," XIX (1910), 21–25. New York: Science Press.

In a contrasted type of cases anticipatory analysis played the leading rôle of determining the main line of solution and accidental impulses were effective merely in the detailed processes.

(1) A number of illustrations of the different ways in which the successes were actually achieved will next be given. These are grouped into four grades or types distinguished according to the relative dominance and temporal priority of accident or of analysis.

(*a*) In the following cases there was no element of anticipation of the result connected with the successful movement:

"The final solution was a sheer accident. I was just starting to put the parts back in the original position in order to begin a new solution, when I thought I saw my way through."

"I have no idea in the world how I did it. I remember moving the loop of the heart around the end of the bar, and the two pieces suddenly came apart."

"I tried random fumbling for several minutes purposely to see if anything would turn up. . . . . I was only inattentively aware of what I was doing and did not plan it out. Was shocked with surprise when the rider came off."

(*b*) In the cases to be given next the successful movement was entered upon accidentally, but was completed purposely and with more or less definite anticipation of the result.

" . . . . So I shook the thing into the original position, and worked with it again aimlessly. The first thing I knew, the pointed ends were through the rings, and by working at this position in a manner hard to describe, I got the two apart."

"I got it off in a way I had decided I couldn't. I saw a little way ahead that it would come off."

"The impulse to swing up the central loop came with a rush. It was followed by a partial perceptual cognition of its correctness."

"I tried this, at first idly, but then, as I progressed, I had a dim idea that I was doing something, and gave careful attention. As I did this, I saw that I had not merely made a difference, but had entirely freed the end of the chain which I had used as a loop, and that therefore I could entirely free the chain from the stick. I saw this a little before

I came to it, but not when I started the movement of the loop through the hole, nor even when I passed the rest of the thing through the loop."

"It seemed convenient to *keep* hold of the ring after I had once started it."

(*c*) In the following group the general locus of the essential movement or some detail of it was determined upon in advance of the successful manipulation but the solution was not worked out in detail and "accident" entered into the final process:

"Then a conspicuous part of one section caught the eye and from that time it seemed certain that it must have something to do with the solution. Work was kept on about that point. The final solution had some element of chance, I do not know just how I did it."

"I tried bending the hinged circle and pushing it through the loops. This came as a perceptual impulse, a sudden glimpse of relations not fully worked out, but fairly clear for the first step."

In the following transitional case the "accidental" impulse following on the preliminary analysis was caught in passage and was terminated purposely:

"The result followed a deliberate attempt to attack the loop end after recognizing the ring end to be impossible. The last step in the solution was a perceptual impulse with a flash of recognition of its similarity to a movement in a similar puzzle."

(*d*) In the following cases the anticipatory analysis was much more complete:

"I knew how to do it as soon as I saw it. A visual image of the corresponding part of the Heart and Bow came on first sight."

"Considerable uncontrolled manipulation was indulged in, but the ring was not gotten off in such manipulation. The random movement seems, however, in some way to have suggested a new way of looking at the puzzle, and the latter ended in its solution. The manipulation resulting in success was here the testing of a definite hypothesis."

"I began with rather aimless placing of pegs in order to get the hang of the moves . . . . made several trials with a little analysis preceding each, but with no attempt at a complete analysis. Each time I would find myself brought to a stop without finishing and would have to analyze. Finally I analyzed the whole thing out beginning at the end, as follows: Since the hole marked 'Havanna' is to be left open till the last (according to directions), the two holes distant two places from this can be left till the next to the last; the two holes distant two places from these come next in order. I followed back in this way till I saw which were the first that must be filled. My analysis worked promptly."

The cases given above were selected from a large number in the most of which the relations are much more complex. In the cases given as illustrating accidental solutions, various unsuccessful attempts to think the thing out or to follow some apparently promising suggestion had been made previous to the successful impulse. As has been previously stated, in most of the cases of accidental success the subject noticed the final position of the parts just after the solution, and so was in a position to eliminate a lot of movements concerned with other portions of the puzzle.

(2) *Difficulty of Anticipatory Analysis.*—In the cases given as illustrating the anticipatory type of solution, it will be noticed that in the second and third the development of a plan of procedure followed upon a period of more or less random manipulation. The first illustration is that of an immediate and total solution. But this subject had already solved a puzzle very similar to the one in question. No cases were found in which a really novel puzzle was "seen through" at once. One of the subjects was given the task of solving a fairly difficult puzzle without touching it. Three hours were spent in consideration of the puzzle before the subject felt sure that he had solved it. Despite the improbability of the references to the parts of the puzzle being intelligible to the reader a quotation or two from the subject's notes may throw some light on the difficulties involved. "I guess this last was wrong, for the folding ring would not drop from the staple to the split ring, as I had thought; and as it does in the case of the small staple, where it falls across without trouble upon the larger staple. But does it do this? It is hard for me to be sure. Simple as the question seems, I can not easily, without trial, make out the answer. But if I imagine a solid ring in the position into which I have supposed the folding ring to 'fall,' I see that it could not be got back into original position of the folding ring, and thence I conclude that I was mistaken in supposing that the folding ring would simply fall over on the large staple. . . . . If I could see how to put the folding ring—supposed to be entirely off—on to the larger staple, I should have it. . . . . I am anxious to put my plan to the test. I believe that I can see through it all right."

The subject then began the actual manipulation to test the theories worked out. "Immediately I met a difficulty, and see that I shall have to analyze further. The difficulty consists in the small ring getting in the way. . . . . Got through the previous difficulty all right, but ran across another."

The difficulties in picturing transformations in three dimensions are so great that few of the subjects tried with any great persistence to think the thing clear through in advance. Then too the impulse to manipulate seemed to be very strong, and this served to inhibit prolonged anticipatory analysis. "I started with the purpose of working by plan only, to solve it with anticipatory analysis, but got too impatient to see the parts in other positions to really test it."

EXERCISES

1. Under what circumstances does the reasoning process occur?
2. Some of us reason more effectively if we can reason aloud, others of us require pencil and paper or a typewriter. Can you explain this fact?
3. Select from your personal experience three cases of problem solving that are analogous to those described by Professor Dewey. Analyze them.
4. Why is it especially difficult to solve mechanical puzzles without actually manipulating them?

5. GENERALIZATION[1]

BY CHARLES H. JUDD

With the value of a simple experiment in mind, I shall try to reduce this problem of theory and practice to a very definite experimental basis. I am sorry that I have not been able to work the problem out more fully. Some ten or eleven years ago Mr. Scholckow, now principal of a New York school, undertook at my suggestion the experimental investigation of this problem. He did not complete the investigation and has never published his result or his method. I later carried the experiment a little further, and shall report on the basis of my results. I wish to acknowledge very fully Mr. Scholckow's contribution, and I secured his consent some time ago to the publication of anything relating to the topic.

Two groups of pupils in the fifth and sixth grades were required to hit with a small dart a target which was placed under water. The difficulty of hitting the target arises, of course, from the deflection which the light suffers through refraction. The target is not where it seems to be, and the boy must fit his aim with the dart to conditions which differ from those which he knows in ordinary life. The amount of refraction and the consequent displacement of the target are capable of definite theoretical explanation before one throws the dart. In this experiment one group of boys was given a full theoretical explanation of refraction. The other group of boys was left to work out experience without theoretical training. These two groups began practice with the target under twelve inches of water. It is a very striking fact in the first series of trials the boys who knew the theory of refraction and those who did not, gave about the same results. That is, theory seemed to be of no value in the first tests. All the boys had to learn how to use the dart, and theory proved to be no substitute for practice. At this point the conditions were changed. The twelve inches of water were reduced to four. The difference between the two groups of boys now came out very strikingly. The boys without theory were very much confused. The practice gained with twelve inches of water did not help them with four inches. Their errors were large and persistent. On the other hand, the boys who had the theory fitted themselves to four inches very rapidly. Their theory evidently helped them to see the reason why they must not apply the twelve-inch habit to four inches of water. Note that theory was not of value until it was backed by practice, but when practice and theory were both present the best adjustment was rapidly worked out.

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[1] Taken from "The Relation of Special Training to General Intelligence," *Educational Review*, XXXVI (1908), 36–39. Doubleday Page & Co., Publishers.

I regret to say that the experiment was not carried far enough to determine how long the boys who were without theoretical training would have had to work at the problem of hitting the target, in order to overcome their confusion with every change in the depth of the water. They did master four inches, but were again confused with eight inches. We may safely appeal to general human experience, however, to supplement our results at this point. Theory has always been built on the basis of series of particular results. When men first observed the results of refraction they were much confused by them. Lucretius, for example, is an illustration of a thinker who has no generalized theory of refraction. He is typical of all ancient observers when he reports the apparent crookedness of a stick in water and declares that it is a deception of the mind. Men could not, however, be satisfied with this vague conclusion. They were stimulated by repeated experiences to attack the facts more vigorously until finally a general principle was formulated. This generalized experience we call the theory of refraction. When one group of boys was instructed in the theory of refraction, they were merely given by a short-cut method the best experience of the race regarding the way to reach objects seen under water. When the boys absorbed this theory they had the epitome of many experiences. The experiment showed that this theoretical knowledge was relatively useless in the first series of tests: that is, until each boy had realized in his own actual contact with water what experiences were discust in the theory. The theory is not a substitute for direct experience; it is rather a frame in which experiences may be properly held apart and at the same time held together. The boys who did not have the theory had experiences, but one experience got in the way of another and there was disconcerting confusion. There was, to be sure, in this confusion a certain relation, but it was of a type opposite in character to that which appeared in the cases of the boys who had the right cue in their theoretical principle and so put the two groups of experiences into the right setting.

Such an example as this makes it clear that every experience has in it the possibilities of generalization. Whether the generalization will be worked out by any individual is a question of that individual's ability and persistence. It is clear, however, that there is nothing in such an experience which would lead us to speak of training as specific and incapable of generalization.

Let us turn from this example to others of a more common type. A boy is taught to look for birds. Does he become more alert in looking for flowers and rocks? That depends entirely upon what looking for birds means in the case under consideration. If a boy is taught in a narrow way to name birds and to look for their nests, with no intimation that there is anything else in the world of nature for which to look, then it is not probable that he will tend to generalize his attitude toward the world sufficiently to include other observable facts. If, on the other hand, a boy is taught to open his eyes to all the facts of the world; if, for example, he is taught that swimming birds have certain characteristics, running birds others, and that certain birds will be found in one kind of an environment, other types in other surroundings, then the tendency to generalize observation will be strong. It is safe to say that looking for birds may be a narrow training in some cases and a very broad training in others. The most important educational principles here involved is not a principle of special mental functions, but the principle that good teaching aims at generalizations.

Again, if we ask whether arithmetic is helpful as an introduction to algebra, the answer depends on what we mean by arithmetic. One of the most vivid educational lessons I ever learned came to me when I once undertook to help some candidates for teachers' certificates review arithmetic. I gave them examples, and the question they always asked me was which rule in the book the example belonged under. Those girls had a kind of arithmetic which would not carry the weight of any algebraical superstructure. On the other hand, I have seen arithmetic taught as a method of comparing quantities in such a way that the transition to algebra could not be felt as anything but a legitimate fruition.

EXERCISE

1. Under what conditions is it unwise to act upon the basis of a generalization?

6. THE THOUGHT CONSCIOUSNESS[1]

BY EDWARD BRADFORD TITCHENER

The thought consciousness itself resembles in general pattern that of active imagination. Active attention is characteristic of both, and in both the content processes depend not merely upon associative, but also and essentially upon determining tendencies, set into activity by the presence of a particular problem. In imagination, however, the problem is the production of a single, and as yet unrealized object: a machine, a future event, a work of art. In thought, on the other hand, the problem is the relation of some object of thought, taken by the thinker as real, to other objects or to truth. This difference of problem involves first a difference of attitude; in imagination the attitude is that of newness or strangeness, while in thought it is that of validity or consistency. More importantly, it involves further a typical difference in the course of consciousness. Imagination begins with a more or less complete apprehension of the requirements to be met, proceeds by a sort of constructive realization, and ends with an idea which satisfies those requirements. Thought typically begins with the aggregate idea, advances by repeated dissections, and ends when the various parts or aspects of the idea have been completely related. These features of similarity and difference have been expressed in the exaggerated statement that imagination is thinking in images (typically concrete), and thought is imagining in words (typically abstract).

EXERCISE

1. Give the gist of the foregoing statement in your own words.

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[1] Taken from "Thought," *New International Encyclopaedia* (2d ed.), XXII (1914), 249.

7. REASONING AND PERCEPTION COMPARED[1]

BY ALFRED BINET

The percept is a complicated structure, made up of sensations and images, and evidently formed of several layers. We are already a long way from the common opinion, according to which the function of the mind which perceives an object is that of the sensitive plate of a photographic apparatus; in proportion as we get still nearer to the heart of our subject, we shall be more and more convinced of the insufficiency of that comparison.

We have several times, in alluding to the psychological nature of perception, seen in it the result of unconscious reasoning. Although this point is generally admitted by contemporary psychologists, save for some variations and some minor reservations, it forms too important a part of our subject to allow us to accept it without discussion and without proof. This is a question which deserves to be attacked directly.

Before discussing a problem, its terms must be very accurately stated. We do not intend to compare perception with formal reasoning in all particulars. It is plain, if the proposition be understood in that sense, that what we are maintaining becomes a paradox. It is paradoxical to maintain that the act of recognizing an object by sight or touch resembles a syllogism. Therefore we do not go so far as that; and the reason why we dwell upon this matter is in order to beg our critics not to attack us by trying to refute what we have never said. What we do say, what we believe to be true, and what we shall proceed to demonstrate, is that in formal reasoning there are essential characteristics which we again find in external perception; that these two acts, so dissimilar in appearance, have yet the same internal structure, the same *ossature*. To employ a comparison drawn from natural history, external perception is an act of reasoning in the same way as the amphioxus, which has no vertebrae, is a vertebrate.

To demonstrate this proposition, we may take at hazard an example of external perception and an example of formal reasoning, and compare the two. Let us compare *the perception of an orange* with the familiar syllogism of the schools: *All men are mortal; Socrates is a man, Socrates is mortal.*

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[1] Adapted from *The Psychology of Reasoning* (3d ed.), pp. 79–88. (Translated from the second French edition by Adam Gowans Whyte.) Chicago: Open Court Publishing Co., 1912.

When we look at an orange we experience a certain number of impressions. There is at first a visual impression of colour, of lights and shades, formed really by a very complex aggregate of simple sensations. The muscular apparatus of the eye, awakened by the excitation of the retina, becomes the seat of contractions which are accompanied by definite muscular sensations; the contraction of the pupillary opening, the convergence of the axes of the two eyes, the contraction of the muscle of focal adaptation, the movements of the eyes in their sockets, etc., must be noted; there are also the movements of the head, neck and trunk, which are unconsciously performed so as to allow the luminous rays to reach the surface of the retina and the most sensitive part of that surface—that is to say, the yellow spot. These are almost all the real sensations which we receive from the object or in connection with the object; everything else about it is indirectly known, in the state of images.

Thus the direction and the distance of the object—that is to say, its position in space—and its size, are three important facts furnished, not by the senses, but by the mind. This is not all. *We believe we see*—that is to say, we see by the mind's eye—the spherical form of the orange, its glossy and dotted surface, the juice which it contains, the complicated arrangement of its internal parts, the presence of seeds, and at the same time *we believe we feel* its weight, its slightly elastic consistence, its odour, its taste, and *we believe we hear* its name pronounced.

If we continue to look at the orange, we induce the revival of images relating to its practical utility, to the act of cutting it with a knife, of carrying it to the mouth, of sucking it and throwing away the pulp and the pips.

If we now compare the perception of an orange with an act of formal reasoning having as its object the death of Socrates, what analogy will be discovered?

First.—It is hardly necessary to remark that these two acts belong to indirect and secondary knowledge. When we assert the future death of a living person, basing our assertion on the death of other men, our assertion anticipates the course of events; it is a prevision. In the same way, when we look at an orange and affirm, explicitly, or implicitly, it does not matter much, that "this is an orange," we pass beyond, by a mental act, the limit of our actual experience. This is precisely what the preceding analysis aimed at showing. The characteristics of structure, weight, taste, etc., attributed to an orange are not comprised in the visual impression which comes from the orange;

to assert their existence is therefore to go beyond the sensation, to accomplish an act which depends upon indirect knowledge. Every perception resembles a reasoned conclusion; it contains, like the logical conclusion, a decision, an affirmation, a belief, relating to a fact which is not directly known by the senses; it is, in other words, a transition from a known fact to an unknown fact.

Second.—The two acts which we are comparing have a common feature in implying the existence of certain anterior intellectual states —that is to say, of recollections. In formal reasoning, these preparatory states are called premises. Without premises, there can be no conclusion. Our mind only accepts this proposition, "Socrates is mortal," because it knows the truth of a different proposition, "All men are mortal." Here there is, besides, a distinctive characteristic of all the indirect processes of knowledge; being indirect, they necessarily demand a proof. It matters little whether this proof be or be not present to the mind at the moment when we make use of it; what is sufficient and essential is that we should have known it. Thus there are many simplified acts of reasoning whose premises are unconscious. The majority of the inferences which we make daily for the practical needs of life are of this nature. Mr. Spencer gives an interesting example.

"It is stated that Mr. So-and-so, who is ninety years old, is about to build a new mansion, and you instantly laugh at the absurdity—a man so near death making such preparation for life. But how came you to think of Mr. So-and-so as dying? Did you first repeat to yourself the proposition, 'All men must die?' Nothing of the kind. Certain antecedents led you to think of death as one of his attributes, without previously thinking of it as an attribute of mankind at large. To any one who considered Mr. So-and-so's folly not manifest, you would probably say, 'He must die, and that very shortly,' not even then appealing to the general fact. Only on being asked *why* he must die, would you either in thought or word resort to the argument, 'All men die, therefore So-and-so must die.'"

We know, according to Mr. Spencer, that the syllogism represents not the process by which the conclusion is reached, but the process by which it is justified, in other words, the syllogism, by conveniently exhibiting the data of an act of reasoning, enables us to see whether we are asserting more than we absolutely know, and whether the conclusion is really involved in the premises, as we suppose it to be. The example quoted explains this theory.

Returning now to the perception of an orange, we shall have no trouble in proving that this act demands, as does an act of reasoning, logical antecedents. What our eye lets us know directly is the impression of a yellow spot; no one will maintain that we are able, apart from all experience, and by a kind of pre-established mechanism, to conclude from this sensation that there is an orange in our hand, a fruit which we may cut, eat, suck, and which quenches thirst, etc. If no experience had ever intervened, our intellect would see nothing beyond our actual sensation, and there would be no perception, in the proper sense of the word. If, on the contrary, we are able to recognize the orange, it is because our eye has received previous education; it is because we have learned to associate, on other occasions, a certain visual impression (the sight of the orange) with all the other impressions which we formerly experienced when we took the orange in our hands to cut and eat it.

This is therefore the second point of contact between the perception of an exterior object and an act of reasoning. These two acts imply older states, recollections. These logical antecedents are called *premisses* in reasoning and *anterior experiences* in perception. The premiss of the reasoning analyzed are, "All men are mortal." That of perception might be, strictly speaking, formulated in an analogous fashion: "All spherical bodies of yellow colour and of a certain size are fruits filled with a sweet juice." However that may be, we see that perception consists, like reasoning, in the application of a recollection to the knowledge of a new fact, and ends in the generalization of this recollection.

But that is not all.

If in the majority of reasonings the premises remain unconscious, in all or almost all cases of perception, the anterior experiences which render them possible are recalled to the mind as little. Thus, when we see a certain yellow spot, we immediately affirm "this is an orange"; there is no conscious return towards the past, and consequently no allegation of proof. It is only if we throw doubt upon the accuracy of our perception that we invoke our past experience, exactly as in our everyday experiences.

Third.—We proceed with our parallel to see how far it is justified. We know that the foundation of all reasoning is the recognition of a *similitude;* reasoning may be roughly defined as the transition from a known fact to a second unknown fact, by means of a resemblance. When we mentally read over the following syllogism, "All men are mortal; Socrates is a man, therefore Socrates is mortal," we pass from a known fact (the mortality of men) to an unknown fact (the death of

Socrates), by virtue of the relation of resemblance which we discern between the two facts; this resemblance forms the object of a special proposition, "Socrates is a man." There is no act of reasoning in the world which does not contain, after the manner of this example, the affirmation of a resemblance; but this affirmation takes different forms and is called by different names: comparison, classification, recognition, etc. We even know that the school of Aristotle compares reasoning to a classification. To conclude that Socrates is mortal would be to put Socrates in the class of men, of whom mortality is an attribute.

The perception of an exterior object implies a similar act of identification. In order to recognize, with the sight alone, that we have before us an orange, it is not enough that past experiences should have formed an association between a piece of yellowish-red colour and certain characteristics of structure, touch, taste and weight; it is necessary, in addition, that a resemblance should exist between the two experiences, past and present; it is necessary that the two pieces of colour should have the same colour, the same tint. We do not generally reflect in order to assure ourselves of this resemblance by a voluntary act of comparison; but it is none the less true that it, the resemblance, must exist. Further, we are, in the majority of cases, very quick to distinguish a real resemblance from a deceptive analogy.

Some authors have also compared perception to an operation of classifying, as has been done in the case of logical reasoning. According to them, the visual perception of an object would consist of classing the sensation which we experience in the group of analogous sensations which have formerly been experienced. This idea has been developed at length by Mr. Spencer.

In short, perception and reasoning have the three following characteristics in common: First, they belong to mediate and indirect knowledge; second, they require the intervention of truths formerly known (recollections, facts of experience, premisses); third, they imply the recognition of a similitude between the fact affirmed and the anterior truth upon which it depends. The union of these characteristics shows that perception is comparable to the conclusion of logical reasoning.

EXERCISE

1. What are some of the inferences implicit in the visual perception of a mountain at a distance? In the auditory perception of a passing automobile?

8. TYPES OF RATIONAL PROBLEMS[1]

BY HARVEY A. CARR

The conditions under which concrete behavior problems arise have been stated. Much the same description will apply to the situations which are solved by a process of reasoning. (1) Just as an animal may lack an adequate motor response, so may a rational subject lack the requisite ideational knowledge, and to solve the problem the subject must seek this knowledge through some social channel. A physician, at a loss to know what to do in encountering some unfamiliar condition in his professional practice, will make inquiries from his associates or seek for this information from medical text books. (2) The requisite knowledge may be potentially inherent in the stock of experience which the subject has already acquired, but it needs to be discovered by a process of analysis and reconstruction of this data. A teacher of geometry, in assigning an original problem, knows that each member of the class has all of the information necessary for its solution. The students may fail to solve the problem, however, because they are unable to effect the proper reorganization of that knowledge. (3) The subject may possess the requisite knowledge in a serviceable form, but the concrete situation with which he is confronted may fail to elicit it. In this case the problem is primarily one of memory. To be readily available, knowledge must be associated with those prospective situations in which it is potentially useful. This principle accounts in part for the effectiveness of knowledge gained from practical experience, for obviously such knowledge must necessarily become associated with the type of situation in which it will be of service. Scholastic knowledge is often not utilized in after life as effectively as it might be because it was taught as an end in itself. A child in the grades may master the principle of computing the capacity of a liquid container from its linear dimensions and readily solve such problems as are formed in the texts, but fail dismally in meeting such a situation in practical life. This inability, however, is not peculiar to youth or primary instruction. The same difficulty may confront a college graduate in the attempt to use his knowledge of chemistry and mathematics in industrial work.

A conflict between two mutually exclusive tendencies also constitutes a problematical situation. (1) An organism may possess several antagonistic modes of responding to the same object, such as curiosity and fear in the presence of a novel situation. With the greater complexity of organization involved in ideational development, the possibilities of responding to a given object in diverse ways are proportionally increased. (2) An organism may be subjected to the opposing influences of two stimulating objects, each tending to elicit an appropriate response. The nesting bird may be swayed by the impulse to incubate her eggs and her fear of the approaching intruder. The possibilities for this type of conflict are almost indefinitely increased with the development of ideas. Without ideas, an organism can be subjected only to the opposing influences of objects which are present to sense. With the possession of ideas, a person may experience a conflict between the tendencies awakened by two ideas or between a response to an object of sense as opposed to one to an object of thought.

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[1] From the manuscript of a textbook in psychology.

The extent to which a rational being is subject to conflicts throughout life may be illustrated by the citation of numerous examples. (1) There are the temporal conflicts between remote and more immediate ends. Shall one buy a machine or accumulate a competence for old age or a rainy day? Shall one gratify his palate or eat sparingly and wisely in the interest of future health? (2) There are the conflicts between individual and selfish aims on the one hand and social and altruistic objectives on the other. Shall the child gratify its own impulses or respect the rights and feelings of others? To what extent shall a boy assert his own independence or be dominated by his more masterful companions? To what extent shall one conform to social customs and conventions or act in accordance with his own beliefs and desires? Shall one live a life of pleasure or make certain sacrifices in order to aid the more unfortunate? (3) Somewhat similar are the conflicts between the so-called lower and the more ideal aspects of personality,—between living a life of gross sensuality or seeking to satisfy one's intellectual, spiritual and aesthetic tendencies. (4) There are the problems of choice between future alternatives,—whether a girl shall choose a career in preference to marriage, whether the youth shall become a merchant or a lawyer, and whether the speculator shall go short or long on the market. (5) Conflicts are incidental to the normal development of every personality. Old beliefs, habits of thought, and attitudes toward the world must be continually discarded or reorganized as an incident of growth and a wider contact with life. These developmental conflicts are peculiarly characteristic of adolescence and early maturity. Adolescence has been aptly termed the "storm and stress" period of life. New interests and attitudes develop as a consequence of the emergence of the sexual tendencies. Shortly after comes the break with home ties, the cessation of parental control and domination, and the necessity for self-reliance and independence of thought and judgment. Coincident with this development, the youthful individual frequently comes into contact with a social group whose beliefs and attitudes toward life differ radically from those of his home environment. Readjustments of this sort frequently constitute the most serious type of problem, and a failure to effect their satisfactory solution may spell moral and spiritual disaster. (6) Human nature is quite complex and it may exhibit many glaring inconsistencies between its several aspects. One's attitudes and principles of conduct in politics and business do not always square with his conduct in church, at home, and in his social circle. Every human being is to some extent a potential Dr. Jekyll and Mr. Hyde. Theory often conflicts with practice. Law and justice are not invariably synonymous. The high minded politician may find that his ideals fail to work and decide to sacrifice something to expediency in order to gain some legitimate end. The sincere philanthropist is often sorely embarrassed by the fact that his attempts at social amelioration do as much harm as good. There are also the conflicts between bodies of knowledge. One's notions concerning science, philosophy and theology often exhibit many antagonistic logical implications. Neither is there complete consistency inside any special branch of knowledge such as chemistry or psychology. Many facts can not be subsumed under any known theory, and assumptions and theories that nicely explain one series of phenomena may be inconsistent with the accepted mode of explaining another series of facts.

Adolescent youth is quite impatient and is usually desirous of an immediate and final settlement of all the problems of life, and as a consequence is inclined to pessimism when he begins to realize the hopelessness of the task. Too many problems require the cooperative effort of a number of generations for their solution. Moreover, the attainment of a permanent condition of mental peace and contentment represents a false ideal of individual development. A Utopian state of society will never be realized. Life is rather a process of growth and development and continuous readjustment, and new problems will continue to arise as fast as the old ones are solved or are outgrown.

EXERCISE

1. Thought often makes possible a better adjustment to our surroundings. It is also true that, in certain situations, the individual who thinks least is most efficient. Explain.

CHAPTER XVII

FEELING

1. PLEASANTNESS AND UNPLEASANTNESS[1]

BY HERMANN EBBINGHAUS

Sensations and their images are closely related mental states. They are of the same kind. As a third class of elementary mental states the feelings of pleasantness and unpleasantness are customarily added. But it would probably be more correct to say that these feelings are mental states of an altogether different kind, in comparison with which the distinction between sensations and images disappears. Pleasantness and unpleasantness never occur apart from sensation or imagery, whereas the latter states of consciousness may be free from any pleasantness or unpleasantness. The pleasantness which I experience is always the pleasantness of something—of the taste of a peach, or of my good health, or of a message received. However, we must not conceive this dependence of pleasantness and unpleasantness as similar to the dependence of color or pitch or spatial extent or duration on the thing to which these belong as its qualities. Color, pitch, and these other qualities are essentially determined by objective conditions, the physical properties of the thing in question. But pleasantness or unpleasantness is only to a slight extent, if at all, determined by objective conditions. Honey tastes very much the same whenever we eat it. A tune sounds very much the same whenever we hear it. But these sensory experiences are, in consequence of subjective conditions, now highly pleasant, now almost indifferent, now decidedly unpleasant.

The same colors and straight lines may be combined into a beautiful design or into an ugly one, the same descriptions of scenery and events into an attractive or a tedious book. A feeling which is already in existence may prevent the growth of an opposite feeling. On a rainy day we are likely to feel as if everything in the world were gray; on a sunny spring day as if everything were rosy. The grief-stricken or desperate person experiences a given situation with other feelings than the person full of joy or hope. A particularly strong factor in our life of feeling is the frequency of recurrence of a situation. The most beautiful music suffers from being played at every concert and on every street, the most delicious dish from being put on the table every day. On the other hand, a bitter medicine gradually loses its unpleasantness, an unpleasant situation becomes indifferent to a person whose profession compels him to face it frequently. As the unchanging is at a disadvantage in our life of perception, so is the recurrent in our life of feeling.

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[1] Taken from *Psychology*, pp. 81–84. (Translated and edited by Max Meyer., Boston: D. C. Heath & Co., 1908.

The subjective factor which determines what feelings accompany our perceptions may be defined as the relation of the situation perceived to the weal and woe of the organism. Pleasantness indicates that the impressions made upon the organism are adapted to the needs or capacities of the organism or at least to that part of the organism which is directly affected; unpleasantness indicates that the impressions are ill adapted or harmful. Exceptions to this rule may be explained through the great complexity of the situations by which the organism is often confronted, and through the complications resulting from the fact that the organism must adjust its activity not only to the present but also to the future, and not only in harmony with the present but also with past experience. Feeling is a reliable symptom and witness only for the present and local utility or inadequacy of the relation between the organism and the world. It is not a prophet of the future. Disease may result from eating sweets, whereas medicine is often bitter.

The addition of feeling to our perceptions and images, because of the peculiarities just mentioned, brings about great complications in the make-up of our mental states and increases enormously the task of classifying and comprehending our states of consciousness. The feelings accompanying images are originally the same as those which accompanied the perceptions in question. The memory image of the pain of flogging is unpleasant because the original pain was unpleasant. But the manifold connections of the images often result in unexpected feelings. The memory of an unpleasant experience may become a source of pleasure through the additional thought that the experience was the result of some folly of which one is no longer capable. The feeling accompanying a perception can change in a similar manner. A saturated green, as the color of a pasture or of an ornament, is pleasant; as the color of a girl's cheek it would be highly unpleasant.

EXERCISE

1. Enumerate some situations (not those mentioned in the text) that have aroused in you a constant or nearly constant group of sensations and images, but varying feelings. How do you account for these differences in feeling?

2. THEORIES OF FEELING

A. The Tridimensional Theory of Wundt[1]

BY MARY WHITON CALKINS

Wundt includes in the class of the affections, or "feelings," four elements or (rather classes of elements) co-ordinate with pleasantness and unpleasantness. These four are: tension and relaxation, excitement and quiescence. Relaxation is opposed to tension and quiescence to excitement, as pleasantness is opposed to unpleasantness, so that we have three pairs of opposites, or, as Wundt calls them, "dimensions" of feeling.

a) The arguments for this view may be summarized as follows: The Wundtians point out in the first place that emotional states differ, according to common consent, not merely as pleasant and unpleasant, but also as exciting or quieting, straining or relaxing. Both melancholy and terror, for example, are unpleasant emotions, yet the first is quieting, or depressing, while the second is as clearly exciting.

b) This purely introspective argument is verified and supplemented by experiment. Alechsieff, whose experimental study is one of the best and most recent of those put forth by members of the Wundtian school, stimulated his subjects in such wise as presumably to bring about emotional experiences, and recorded both pulse and breathing, and introspection. The introspective records first (1) clearly indicated the occurrence of straining and relaxing, exciting and depressing emotions; next (2) sometimes asserted the occurrence, in emotional experiences, of elemental consciousness other than sensations, pleasantness and unpleasantness; finally (3) showed that either pleasantness or unpleasantness may occur in combination with any one of the four other "feelings." In other words, the records indicated that in pleasurable emotion subjects were sometimes in a state of tension, but sometimes relaxed, sometimes excited, and sometimes depressed; and that in unpleasant emotion subjects were now relaxed, now strained, and now excited, again depressed. The objective results of these experiments are summarized by Alechsieff in the following scheme adapted from Wundt:

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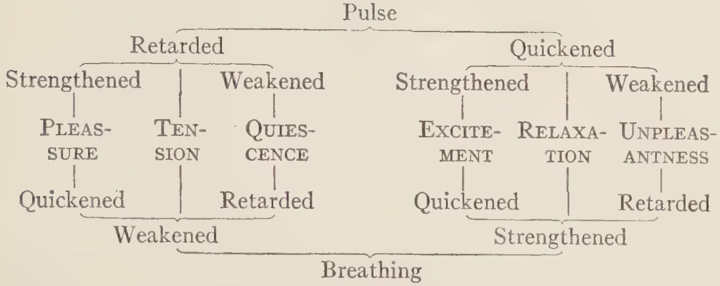
[1] Adapted from "The Abandonment of Sensationalism in Psychology," *American Journal of Psychology*, XX (1909), 269–71.


Pulse
Retarded
Quickened
Strengthened
Weakened
Strengthened
Weakened
PLEASURE
TENSION
QUIESCENCE
EXCITEMENT
RELAXATION
UNPLEASANTNESS
Quickened
Retarded
Quickened
Retarded
Weakened
Strengthened
Breathing

The Wundtian conclusion from both sorts of evidence is the following: Experiences which are thus shown to be, on the one hand, introspectively elemental, distinct, and independently variable and, on the other hand, accompanied by clearly differentiated yet coordinated circulatory and respiratory phenomena, are elements of consciousness belonging in a class together. Therefore tension-relaxation and excitement-quiescence form, with pleasantness-unpleasantness, the enlarged class of the "feelings."

This theory has, however, found little favor outside the narrow circle of Wundt's fellow-workers and students. Against the Wundtian arguments from experiment it is urged by the critics that the outcome of experiment is very far from conclusive in Wundt's favor. Even experiments undertaken from the same theoretical standpoint as Alechsieff's issue in results of very conflicting nature.

B. The Bidimensional Theory of Royce[1]

BY JOSIAH ROYCE

I venture to advance the hypothesis that our feelings differ from one another *in at least two decidedly distinct and relatively independent ways*, while I am uncertain whether Wundt's *three* dimensions, or some still more complex account, may not prove in the end to be more acceptable. I limit my hypothesis to *two* relatively independent "dimensions" of feeling, only because *at least so much* variation seems very probable, while more "dimensions" seem less probable. In each of these two ways in which feelings can differ, I find mutually opposed kinds, or antagonistic characters of feeling. *First*, then, *feelings differ as to their pleasantness and unpleasantness*. In so far we have *the pleasure-pain dimension*, as it might be called, of the variation of the feelings. At the same time the feelings differ *as being more or less either feelings of restlessness or feelings of quiescence*. By *restlessness* and *quiescence* I mean a sort of antagonism introspectively easy to observe, but rather easily confounded (as I readily admit) with those aspects of sensory experience which guides us in knowing what movements we are making. By a feeling of restlessness I mean, however, *not* the sensory experience of movements that we are actually carrying out, but *the feeling of that value of our experience which makes it an object of momentary discontent*. By a feeling of quiescence, on the other hand, I do not mean exclusively such a feeling as is associated with the word "contentment" when that word is opposed to the word "discontent," because by the word "contentment" language has come to mean a feeling of quiescence which is *also* one of pleasure; while feelings of quiescence, as I shall point out in a moment, may be relatively painful. The word "quiescence" does, however, fairly express my meaning. I shall now illustrate the ways in which, as I maintain, feelings *can vary in either one of these two dimensions, or types of variation, in such fashion that instead of two, there will be at least four principal kinds of mixed feeling present in various states of consciousness*, as well as two pairs of mutually antagonistic, unmixed forms of feeling possible.

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[1] Adapted by permission from *Outlines of Psychology*, pp. 178–88. New York: Macmillan Co. Copyrighted, 1903.

First, then to call attention afresh to Pleasure and Displeasure. *Pleasures* are feelings that seem to accompany states in which the organism is being, so to speak, *built up*, or *prevailingly refreshed*, so that *its vitality is for the moment heightened*. *Pain* or *displeasure* is such feeling as is predominant at moments when the organism *is breaking down, or is being lowered in vitality*. In so far, pleasure and displeasure tend to reflect a condition of the organism as a whole, although at any moment they may, in my opinion, be more or less mixed, just because the processes that have to do with increase and decrease of vitality are so complex, and are so imperfectly represented in consciousness. Meanwhile, pleasure and displeasure, when they appear, are *aspects or qualities of conscious states in so far as they are now present, and not in so far as our consciousness emphasises these changes which are constantly going on in the conscious field*.

On the other hand, *restlessness and quiescence are sorts of feeling that have to do with our consciousness, not of any particular movements* *but of the general tendency to a change in the motor processes present in our organism.* In consciousness itself these feelings therefore have to do with *the changing or temporal aspects of our conscious states.* We tend on the whole to regard with restlessness whatever tendency involves our interest in immediately future changes. The emotions of expectation, of curiosity, of fear, of hope, of suspense, are accordingly especially coloured by restless feelings. The feelings of quiescence predominate when no change is notably interesting to us, or when no conscious stress is laid upon the changes that are occurring. In consequence, we regard the past, when we look back to it, with a quiescence which we do not generally adopt toward the future. The complex mood called "fatalism" is one in which all happenings, both past and future, are regarded with a predominance of those quiescent feelings that usually predominate when we think of the past. Hence the fatalist views the future as having the same value for his feelings that the irrevocable past [illegible] has. Again, quiescent feelings predominate both when we [illegible] sleep, and when we suffer from marked and long-continued [illegible] depression. Restless feelings predominate when we are wide awake, or when the stored energies of the organism are in a condition which disposes them to rapid and vigorous discharge. What is commonly called active attention, as when we listen intently for a faint sound, is characterised by feelings of restlessness. The so-called passive states of one who helplessly observes a present object is characterised by a predominance of quiescent feelings.

The restless and the quiescent feelings may, and in general do, *colour particular sensory experiences.* That is, we may be prominently conscious of the sensory experience, and of what it means, and may, at the same time, be aware of its value as one which arouses us to rest[illegible]ity, or which leaves us quiescent. It seems to me an inadequate statement to identify our feeling of restlessness with the sensory experience that informs us of what movement we are making at a moment when we are active. *We are restless in so far as we are actively dissatisfied with a present experience, and are so disposed to change the experience.* The *result* of this dissatisfaction will in general be a consciousness of movement. While the movement is going on, every stage of it will be somewhat unsatisfactory, and our consciousness will be one of restlessness. *But our consciousness that we are moving is a sensory experience. Our consciousness that we all the while feel restless, or disposed to move,* constitutes the feeling here in question. This feeling makes us aware of the value of our present state, which in case of restlessness is a value that we desire momentarily to change.

And now for the relation between the pleasure-pain dimension of the feelings and the second dimension, that of restlessness and quiescence. It is true that, as the customary view says, we never wholly "acquiesce" in presence of pain or of the disagreeable. There are sufferings which leave us relatively quiescent, while there are sufferings which are accompanied with vigorous restlessness. When a physical pain begins, we are restless, and our feelings include those usually called rebellious. After hours of suffering, we may remain still as clearly conscious of the pain as ever, and quite as ready as ever to call it intolerable. That is, our unpleasant feeling is as notable as ever. But we may find ourselves very much less disposed to any present tendency to change our situation. We then fall into the state of passive suffering. We even feel that we *could not* do anything, that we have no tendency to strive against the pain. In this case, we combine suffering with quiescence of feeling. The emotion called "despair" is a classic instance of such an union of unpleasant feeling with predominantly quiescent feeling. Various classes of nervous sufferers confess such an union of pain and quiescence as something which they themselves find puzzling. The apathetic stages of nervous exhaustion may furnish instances of which the patient describes as great suffering, but as misery against which he has no conscious tendency to contend.

Pleasure may be of the restless type. In this case, *although we like what we have, we are dissatisfied with the situation, and restlessly seek for more.* In active temperaments and states of mind this character of pleasant feelings becomes very prominent; hence those observations of the *dissatisfying character of the pleasures* which are found so richly scattered through the writings of poets and moralists. They rest, I think, upon the basis of a sound introspection.

From the psychological point of view, it is indeed possible that *pleasure should be associated with a* relatively, although never absolutely, perfect *feeling of quiescence. In this case the pleasure is of the kind that satisfies.* The conscious attitude is then one, *not* of seeking for more pleasure, but *of desiring nothing more*, and nothing other than what we have. The attainment of this state is indeed never complete, but constitutes an ideal limit of our conscious search for pleasure.

From the point of view now advanced there would therefore be at least possible four distinct kinds of mixed feelings, due to the union of the two pairs of characters, or of the two dimensions of feelings now defined. These four kinds would be: First, *the pleasures that are quiescent.* These would be illustrated, especially, by instances of what is usually called contentment, as opposed to discontent. The quiescent pleasures would again be *the most distinctly satisfactory sorts of feeling that we possess*, so far as the judgment of the present moment is concerned.

Second, we find the *dissatisfying pleasures*. These have the present character of being pleasant. On the other hand they are distinctly unsatisfactory. As we have already pointed out, the dual theory of the feelings finds it very difficult to assign to them a definite place.

The biological importance of this union of pleasure and dissatisfaction is very great. The normal animal, engaged in successful activity, experiences many states of consciousness that accompany heightened vitality and that are accordingly pleasurable. But since its relations to its environment need constantly fresh readjustment, such an animal must feel not merely the pleasure, but the incompleteness of its present state, in order that it may constantly desire such readjustment.

Third, we find in many feelings the *union of the painful and the restless*. Our experience is painful in so far as it accompanies a certain present diminution of the energy at the disposal of the organism, or in so far as the present situation is more or less injurious to the organism. Such pain is, in so far, very naturally accompanied with dissatisfaction. But since dissatisfaction can accompany pleasure without thereby necessarily involving the distinctly painful feeling, we must indeed *distinguish between the restlessness that accompanies suffering and the suffering itself*.

Fourth, we may have, in certain feelings, *the union of suffering and quiescence*. As already admitted, this quiescence is never an absolute indisposition to make any change whatever.

C. Feelings as Indefinite Sense Qualities[1]

BY KNIGHT DUNLAP

The nature of feeling.—Feelings are actual data in experience. They are facts, not inferences; and they are contents of which we are aware. They are comparable to sentienda,[2] in that they have intensity, duration, and sometimes even extensity, and are spatial to the extent of being located within the body. Not only the feelings which are classed as sentienda, such as pain and fatigue: but also the unquestionably affective contents such as joy, amorousness, and rage, are distinctly within the confines of my body; not in the outer world, and not, like awareness, exempt from space limitations.

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[1] Taken from *The Elements of Scientific Psychology*, pp. 312–14. St. Louis: C. V. Mosby Co., 1922.

[2] Sensations.—EDITORS.

Feelings, then, must be something experienced through reactions which are initiated by the stimulation of receptors just as sentienda are experienced. We might say that feelings are perceived, but it is better to retain the term perception to apply to external perception only, and apply the more general term *intuition* to internal experiencing.

The existence of a class of sentienda (pain, warmth, fatigue) which are persistently classed with feelings, and the existence of a second class of content, (hunger, thirst, fullness, etc.) which are sometimes classed as sentienda and sometimes as affects, gives the clue to the real nature of feelings. They are *organic*, or *bodily sentienda:* details of the soma[1] and viscera, and of changes in soma and viscera, as those details and changes are intuited or experienced. The classification of warmth, cold, pain and pressure as feelings is quite intelligible. In so far as warmth and cold are properties of the body, they may truly be feelings. In so far as they are properties of external objects, they cannot be feelings.

But even those contents which are always properties of the body may at times not be feelings. Pain, always in the body, may be a feeling, or it may be a sentiendum of the organic sense. Hunger and thirst are not classed merely inconsistently now as feelings, now as sense data. Actually, these data may be feelings at one time, and not at others.

The essential characteristic of a feeling is its vagueness and lack of definitely perceived pattern. It is not even definitely localized; in its most truly characteristic condition, it is just "inside." However complex it may really be, its complexities are not perceived. In so far as the feeling is analyzed and localized, it ceases to be a feeling and becomes organic sense-data. The emotion as intuited may be compared to the sound of an orchestra to a man who has previously heard no musical instruments, but whose auditory mechanism is perfect. The sound is to him a vast, insistent, *general* noise, however rich and impressive it may be. The shrilling of the chorus of strings in one passage, and the blaring of the brasses in another may be markedly different to him; but he discriminates no details in either. The sound to him is actually a *feeling*,[2] added to his complement of bodily feelings.

[1] The body wall.—EDITORS.

[2] This is, of course, over and above the bodily feelings aroused by the music, although the latter are directly affected by the former.

Even to the partially sophisticated listener, and to the trained listener, in his unanalytical moments, the orchestral synthesis has a feeling characteristic, which is lost when the pattern is analyzed.

The bodily sentienda are preeminently fitted to merge as feelings, because of the great difficulty in analyzing and localizing them. The auditory, dermal and visual data are analyzable because they are readily variable. By controlling the stimulus, and by motor adjustments, fine variations are produced in the stimulation, and the data are thereby analyzed. But in the case of the viscera, and to a large extent, in the case of the soma, gross variation in stimulation, and that not readily controllable, is the most that is possible.

The organic sense data, therefore, remain largely feelings; the rich and general background of experience against which external objects are perceived, and are analytically reduced to mere sense data only by great labor, and even then only in small part. For this reason it is inadvisable to speak of "perceiving" the emotion or feeling, but rather to speak of *apprehending* or "intuiting" it, since "perception" usually connotes an analytical awareness in which details of the content are to some extent distinguished.

EXERCISES

1. Compare the meaning of "feeling" as it is popularly employed (or as you yourself have ordinarily employed it) with the meaning of that term in psychology.
2. To what extent are the foregoing arguments concerned with facts, and to what extent are they concerned with definitions?

3. THE PHYSIOLOGICAL BASIS OF FEELING

A[1]

BY HUGO MÜNSTERBERG

The physiological basis of simple feelings.—What is the underlying physiological process of the simplest feeling state? What is added in our psychophysical system to the process of a slight bitter excitement and of a strong bitter excitement, when one appears pleasant and the other unpleasant? We have a definite basis for a physiological theory if we observe the bodily reactions connected with the sensory pleasure and displeasure. They indicate clearly the antagonism of the feelings themselves. If the stimulus is pleasant, the movements tend to make it go on; if it is unpleasant, the movements tend to stop it. The stimulus continues, if we actively approach it or if we passively yield to it, and it ends if we move away or throw it off. Two groups of antagonistic movements are evidently especially characteristic. If the stimulus is disagreeable, the organism reacts by a contraction of the flexor muscles. It is a cramplike shrinking of the body, a tense strain. If the impression is agreeable, the organism expands, and the extensor muscles are active.

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[1] Adapted from *Psychology, General and Applied*, pp. 198–99. New York: D. Appleton & Co., 1914.

It is the same opposition of movements which can be traced throughout the history of animal life. We saw how the amoeba contracts under the influence of the dangerous stimulus, and expands under the influence of helpful stimuli. If the infant is put into a lukewarm bath, we see these same useful expansions, and if he is held in a bath too cold or too hot, we see that general contraction. Throughout life the approaching and the withdrawing movements are the leading reactions to pleasant and unpleasant stimuli, and under natural conditions the flexor and extensor contractions are their chief factors. Many other secondary centrifugal effects can be traced. The agreeable and the disagreeable states produce opposing reactions in the respiration, in the rapidity and character of the pulse, in the size of the small blood-vessels, in the gland activity, but whatever their biological importance may be, those contractions of approach and withdrawal must stand in the center as they alone have immediate practical bearing.

B[1]

BY FLOYD HENRY ALLPORT

It is evident that the two antagonistic mechanisms of the autonomic nervous system, the cranio-sacral and sympathetic divisions, are allied with two groups of emotions having opposed qualities of feeling, pleasant and unpleasant respectively. The unpleasant group, exemplified by pain, fear, and rage, results from bodily changes which serve the ends of withdrawing and defense, and which are brought about by the sympathetic division. There is no difficulty theoretically in concluding that all conscious states tinged with unpleasant feeling derive that feeling from the invasion of the various bodily organs by impulses from the sympathetic.

The chief pleasures of mankind, on the other hand, center about the cranio-sacral functions of nutrition and sex. The digestive operations induced by the cranial division are probably the reactions whose return afferent impulses convey much of the feeling of pleasure in eating. Salivary and other digestive reactions come by conditioned reflex to be attached to stimuli which accompany the taste of the food, such as the *sight* of the food or surrounding objects. The pleasure reaction is therefore transferred to these attendant stimuli, and our preparatory as well as our consummatory approaching reactions become fraught with pleasant feeling. The same extension applies to the pleasures of the sex life, controlled by the sacral division. The facilitating sacral discharge into the pelvic organs becomes conditioned by the *sight* of the loved one, or even by a token or remembrance, so that the pleasure reaction is habitually experienced as the affective core of the emotion of love. It is not improbable that consanguineal as well as true sexual love derives its pleasantness component in a similar fashion.

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[1] Adapted from *Social Psychology*, pp. 89–90. Boston: Copyrighted by and taken by permission from Houghton Mifflin Co., 1924.

Before reading this selection the student will do well to re-read section 3, chapter iii.—Editors.

A certain exception must be made to the statement that cranio-sacral impulses underlie pleasant emotional states generally. There are several sources of pleasant affectivity, such as bodily exercise and habit, excitement of games, elation, and mirth, which possess no discoverable relation to the cranio-sacral functions, nor (with the exception of excitement and mirth) to autonomic activities of any sort. These pleasant states appear to be due to afferent impulses from reactions carried out by unimpeded *cerebrospinal* impulses. They are somatic rather than visceral in origin.

To recapitulate: Emotions are fundamentally distinguishable as pleasant and unpleasant. The first part of our theory undertakes to explain this affective basis. Finding a certain physiological process to be present in the entire group of unpleasant emotions, and an antagonistic process common to pleasant emotions, we infer that these processes form the basis of conscious unpleasantness and pleasantness respectively. *The cranio-sacral division of the autonomic, supplemented under certain conditions by the cerebrospinal system, innervates those responses whose return afferent impulses are associated with the conscious quality of pleasantness. The sympathetic division produces visceral responses which are represented in consciousness as unpleasantness.*

EXERCISE

1. To what extent do these physiological explanations of feeling fit in with the theories in Section 2?

4. THE CONDITIONS OF PLEASURE AND PAIN (UNPLEASANTNESS)[1]

BY HENRY RUTGERS MARSHALL

(1) All pleasures which we can experience may be referred to one of two great classes:—

(*a*) Pleasures induced by active functioning.

(*b*) Pleasures connected with cessation of activities.

(2) There are states, which are usually called indifferent, in which we note no distinct pleasure or pain quality.

(3) All pains which we can experience may be referred to one of two great classes:—

(*a*) Pains connected with excesses of function.

(*b*) Pains connected with failures to function.

EXERCISE

1. Describe concrete examples of pleasant and painful experiences arising under the conditions above set forth.

5. COMPLICATIONS OF FEELING[2]

BY HERMANN EBBINGHAUS

FEELING DEPENDENT ON ASSOCIATION OF IDEAS

Why does a sunny spring landscape give us pleasure? What is its advantage over a gloomy winter landscape? Possibly green is a pleasanter color than brown or gray, which predominate in the winter landscape. Possibly the curved outlines of the trees in their foliage are more beautiful than the naked branches appearing like a system of dark veins on a gray sky. But these are hardly the main causes of the difference in feeling, which are found rather in the different ideas associated with the one and the other percept. The spring landscape reminds one of life, warmth, travel, picnics; the winter scene suggests death and decay, cold, moisture, overheated and ill-ventilated rooms. The feelings aroused by these things when we actually experience them are likely to be aroused now when these thoughts, however fleetingly, are reproduced. For the same reason the cold sensation of touching a corpse is accompanied by a feeling differing from that of touching a piece of ice. It is a different thing to see a stream of blood or of cherry juice, and in a lesser degree even of cherry juice or milk. In every case a multitude of memories influence our feelings, or lead us directly into a train of thought of pleasant or unpleasant character. Thus the feelings which have their first origin in a simple percept may become exceedingly complicated.

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[1] Taken by permission from *Pain, Pleasure, and Aesthetics*, p. 191. New York: Macmillan Co. Copyrighted, 1894.

[2] Taken from *Psychology*, pp. 164–66. (Translated and edited by Max Meyer.) Boston: D. C. Heath & Co., 1908.

An especially important consideration is that these feelings increase in intensity and finally become more conspicuous than the memories by which they are aroused. A house in which I experienced an unpleasant scene finally arouses unpleasantness directly, without any mediation by the consciousness of that event. This kind of transference of feeling is particularly noticeable when the same feeling is aroused by many different memories, quite unconnected among themselves, though attached to the same percept. No better illustration of this law can be found than the feelings accompanying the thought of money. From early childhood all through life man learns that it is money and again money on which the realization of his desires depends. A definite memory of any of these special experiences soon becomes impossible because of the competition among them. But the pleasantness originally aroused by them is not lost. It attaches itself directly to money. In a similar manner our love for our parents, our friends, our home, and so on, originates. A reverent child may reject as a brutal theory the statement that he loves his parents because of the innumerable benefits received from them, that this love is but a kind of precipitation of all the pleasures derived from the actions of his parents and from his living with them. This rejection is in so far justified as the child's love is not a conscious deduction from the memory of benefits received. Nevertheless, it is quite certain that his love is in some way naturally derived from them. Children who are brought up by foster parents, if they are as well taken care of as by real parents, love them equally well.

EXERCISE

1. Try to explain why you feel as you do in regard to blue, sweet, sour, cake, coffee, sky, water, college, politicians, football, history, psychology.

CHAPTER XVIII

EMOTION

1. THE IMPORTANCE OF EMOTIONS[1]

BY CARL GEORG LANGE

Kant, in a passage in his *Anthropologie*, qualifies the affections as diseases of the mind.

He considers the mind normal only as long as it is under the incontrovertible and absolute control of reason. Anything that causes it to be disturbed seems to him to be abnormal and harmful to the individual.

To a more realistic school of psychology, which knows no abstract "Ideal" man, but rather "takes men as they are," such a doctrine of the soul must appear strange. It must be but a meager conception of man's existence, to consider pain and pleasure, pity and anger, defiance and humility, as conditions foreign to normal life, or even as something from which one must turn away if one wishes to recognize the actual nature of mankind. A theory which makes the power of admiring the great, of deriving pleasure from the beautiful, and of being moved by misfortune, a disease, results in a limitation of the extent of our mental life. Such a theory will consider the imperturbable arithmetic teacher, to whom every impression is merely an impulse to draw rational conclusions, as the only normal, healthy individual. It is a strange conception of the interaction of mental powers to consider as accidental that which plays a larger and more vital part than normal reason in the mental life of most men, and which determines to a much higher degree than reason the fate of nations as well as of individuals.

Who would wish to cure an unhealthy mind, if by so doing he would rob man of all that goes to make him a sympathetic creature; that enables him to share the pleasure and pain of those of his kind; and to admire his like or to hate them? No,—however true it may be that we must eliminate our passions wherever it is a question of calm consideration, clear recognition, or unbiased judgment, it is undoubtedly just as true that we cannot consider an individual who can only think, recognize, judge—but not suffer, fear or rejoice—a true, healthy, complete human being, even if occasionally these abilities may be detrimental to his power of understanding and judgment.

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[1] Taken from *The Emotions*, by James and Lange, edited by Knight Dunlap, pp. 33–34. Baltimore: Williams & Wilkins Co., 1922.

Emotions are not only the most important factors in the life of the individual human being, but they are also the most powerful forces of nature known to us. Every page in the history of nations testifies to their invincible power.

The storm of passions has cost more lives and has destroyed more lands than hurricanes; their floods have wiped out more towns than spring floods of water.

EXERCISES

1. Enumerate some human achievements that would have been impossible in an emotionless world.
2. What part does emotion play in the work of so-called abstract thinkers?

2. GENERAL CHARACTERISTICS OF EMOTIONS[1]

BY G. F. STOUT

If we ask the question, What is an emotion? the first answer that occurs to common sense is a list of specific emotions—fear, anger, hope, suspense, jealousy, and the like. When we push the inquiry further, and ask what character these states have in common which leads us to apply the same name, *Emotion*, to all of them, we find psychologists giving various and inconsistent answers. According to some, emotion is essentially a kind of sensation, due to general organic disturbance. According to others, it is the massive revival by association of past pleasures and pains. According to others, it is a tendency to behave in a particular way, and must be regarded as a mode of conative consciousness. The best course for us to pursue in view of this disagreement, is to take certain typical emotions, and to attempt to fix characteristics distinctive of them and common to them in all their manifestations.

(1) There is one prominent fact about emotion which confronts us at the outset:—its wide range. From the lower forms of perceptual consciousness up to the higher forms of ideational and conceptual activity, the same typical kinds of emotion are everywhere present. Anger may arise in connexion with the pain of a wound or the smart of a blow. The wounded lion bites at sticks and stones and at its own wounds. The cat will become angry if you interfere with its kittens.

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[1] Taken from *A Manual of Psychology* (3d ed.), pp. 405–9. (Revised and enlarged seventh impression.) Cambridge: University Tutorial Press, 1915.

A child will become angry if you take away its toy. A man will become angry if you fail to understand his argument, or if you unfavourably criticise his book. A saint may also be angry *qua* saint, as St. Paul was angry with the foolish Galatians. It follows from this wide distribution of emotion over different stages of mental development that we must be very careful to avoid giving too limited a definition of its specific forms. Bain, for instance, seems to err in this direction when he says that anger "contains an impulse knowingly to inflict suffering upon another sentient being, and a positive gratification in the fact of suffering inflicted." This would only apply to a somewhat developed stage of free ideal activity; and even then it would not cover such cases as St. Paul's righteous anger with the foolish Galatians.

(2) Closely connected with the wide distribution of emotion is the varied nature of the conditions that arouse it. Any kind of thwarting or opposition may excite anger. Any kind of danger may excite fear. You may produce anger in a dog by disturbing it while eating, or by interfering with its young, or by pulling its tail. It is a certain general kind of situation, not a specific class of objects, which excites a certain kind of emotion.

The behaviour in which emotion finds expression is correspondingly general in its character. It is not an adaptation to the specific nature of this or that specific object, but a general mode of action adapted to a certain kind of situation. The behaviour of the angry dog is generically the same, however the anger is excited. It adopts the same bodily attitude, shows its teeth, growls, attempts to bite, and the like.

(3) There are two sources of emotional states which it is important to distinguish. Emotions may arise in connexion with definite perceptions or ideas, as when good news excites joy; on the other hand, they may be primarily conditioned by organic changes, such as those which follow the use of alcohol or other drugs. A man's temper varies with the state of his health. The organic changes may operate in one or both of two ways. They may directly change the condition of the nervous system by altering the nature or amount of nutrition with which it is supplied, or in other ways. They may also, by altering the general state of the body, alter the nature of the impulses received by the central nervous system from the internal organs. Owing to the diffusive nature of organic sensations, this occasions a general change in the state of the nervous system, which on the psychological side is experienced as an *emotional mood*. An emotional mood is not quite the same thing as an emotion properly so called. An emotion

properly so called must be felt in relation to some definite object, to be angry we must be angry about something. But the general state of irritation due, let us say, to a sleepless night, has not, as such, any definite object. As we shall see under (4), it tends to find objects for itself, and it may pass from one object to another, giving rise to a series of emotions of a similar nature. In general, the occurrence of a definite emotion tends to leave behind it an emotional mood akin to it.

(4) An emotional mood, whatever may be its primary origin, tends to persist when once it is aroused, and to fasten upon any object which presents itself. Ill-temper or gloomy depression or hilarity may originate in the first instance in the use of drugs; but when these moods are once in existence they create objects for themselves. A man who gets up in the morning in a bad temper, due to want of sleep or similar causes, is apt to be irritated by almost everything that occurs; though in another mood the same incidents would be received with complacency. The cook angered by her mistress will box the ears of the scullion; a herd of cattle, enraged by the sight of a comrade in distress, will vent their fury on their unfortunate companion; the reason being simply that he is the only object on which their attention is fixed. Their excitement must find an outlet; and in the absence of any other definite channel for it, it discharges itself on the injured animal. "It is sometimes seen in dogs, when three or four or five are met together, that if one suddenly utters a howl or cry of pain, when no man is near it and no cause apparent, the others run to it, and seeing nothing, turn round and attack each other." So it is dangerous to approach the males of many species of animals in breeding time, when their angry passions are aroused by sexual rivalry. An emotion or emotional mood involves a certain general trend or direction of activity, which particularises itself in whatever way it can, according to circumstances.

(5) The fifth feature of emotion is what we may call its parasitical character. So far as emotions are excited by general situations, and not merely by general organic changes, they are usually secondary phenomena, and pre-suppose the existence of more specific tendencies. This is true of all but the simplest and most primitive emotional states. The anger produced in a dog by taking away its bone pre-supposes the specific appetite for food. The anger produced in it by interfering with its young pre-supposes the specific tendency to guard and tend its offspring. So the presence of a rival who interferes with its wooing causes anger because of the pre-existence of the sexual impulse.

(6) In all the more intense phases of emotion, organic sensations form an important constituent of the total state of consciousness. This is true whether the emotion has been primarily introduced by organic changes, or whether it has in the first instance arisen in connexion with definite perceptions or ideas. This fact has been made the basis of a general theory, according to which the essential nature of the emotional consciousness consists in sensations arising from change in the internal organs of the body, including both viscera and muscles.

EXERCISE

1. Describe actual emotional states that you have observed or experienced that illustrate the characteristics of emotions enumerated by Professor Stout.

3. THE JAMES-LANGE THEORY[1]

A[2]

BY WILLIAM JAMES

EMOTION FOLLOWS UPON THE BODILY EXPRESSION IN THE COARSER EMOTIONS AT LEAST

Our natural way of thinking about these coarser emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My theory, on the contrary, is that *the bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur* IS *the emotion.* Common-sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike. The hypothesis here to be defended says that this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be. Without the bodily states following on the perception, the latter would be purely cognitive in form, pale, colorless, destitute of emotional warmth. We might then see the bear, and judge it best to run, receive the insult and deem it right to strike, but we should not actually *feel* afraid or angry.

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[1] This theory was formulated independently at about the same time by William James and C. G. Lange.—EDITORS.

[2] Taken from *The Principles of Psychology,* II, 449–53. New York: Henry Holt & Co., 1890.

Stated in this crude way, the hypothesis is pretty sure to meet with immediate disbelief. And yet neither many nor far-fetched considerations are required to mitigate its paradoxical character, and possibly to produce conviction of its truth.

To begin with, no reader will be inclined to doubt the fact that *objects do excite bodily changes* by a preorganized mechanism, or the farther fact that *the changes are so indefinitely numerous and subtle that the entire organism may be called a sounding-board*, which every change of consciousness, however slight, may make reverberate. The various permutations and combinations of which these organic activities are susceptible make it abstractly possible that no shade of emotion, however slight, should be without a bodily reverberation as unique, when taken in its totality, as is the mental mood itself. The immense number of parts modified in each emotion is what makes it so difficult for us to reproduce in cold blood the total and integral expression of any one of them. We may catch the trick with the voluntary muscles, but fail with the skin, glands, heart, and other viscera. Just as an artificially imitated sneeze lacks something of the reality, so the attempt to imitate an emotion in the absence of its normal instigating cause is apt to be rather "hollow."

The next thing to be noticed is this, that *every one of the bodily changes, whatsoever it be, is* FELT, *acutely or obscurely, the moment it occurs.* If the reader has never paid attention to this matter, he will be both interested and astonished to learn how many different local bodily feelings he can detect in himself as characteristic of his various emotional moods. It would be perhaps too much to expect him to arrest the tide of any strong gust of passion for the sake of any such curious analysis as this; but he can observe more tranquil states, and that may be assumed here to be true of the greater which is shown to be true of the less. Our whole cubic capacity is sensibly alive; and each morsel of it contributes its pulsations of feeling, dim or sharp, pleasant, painful, or dubious, to that sense of personality that every one of us unfailingly carries with him. It is surprising what little items give accent to these complexes of sensibility. When worried by any slight trouble, one may find that the focus of one's bodily consciousness is the contraction, often quite inconsiderable, of the eyes and brows. When momentarily embarrassed, it is something in the pharynx that compels either a swallow, a clearing of the throat, or a slight cough; and so on for as many more instances as might be named. Our concern here being with the general view rather than with the details, I will not linger to discuss these, but, assuming the point admitted that every change that occurs must be felt, I will pass on.

I now proceed to urge the vital point of my whole theory, which is this: *If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its bodily symptoms, we find we have nothing left behind*, no "mind-stuff" out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains. It is true that, although most people when asked say that their introspection verifies this statement, some persist in saying theirs does not. Many cannot be made to understand the question. When you beg them to imagine away every feeling of laughter and of tendency to laugh from their consciousness of the ludicrousness of an object, and then to tell you what the feeling of its ludicrousness would be like, whether it be anything more than the perception that the object belongs to the class "funny," they persist in replying that the thing proposed is a physical impossibility, and that they always *must* laugh if they see a funny object. Of course the task proposed is not the practical one of seeing a ludicrous object and annihilating one's tendency to laugh. It is the purely speculative one of subtracting certain elements of feeling from an emotional state supposed to exist in its fulness, and saying what the residual elements are. I cannot help thinking that all who rightly apprehend this problem will agree with the proposition above laid down. What kind of an emotion of fear would be left if the feeling neither of quickened heart-beats nor of shallow breathing, neither of trembling lips nor of weakened limbs, neither of goose-flesh nor of visceral stirrings, were present, it is quite impossible for me to think. Can one fancy the state of rage and picture no ebullition in the chest, no flushing of the face, no dilatation of the nostrils, no clenching of the teeth, no impulse to vigorous action, but in their stead limp muscles, calm breathing, and a placid face? The present writer, for one, certainly cannot. The rage is as completely evaporated as the sensation of its so-called manifestations, and the only thing that can possibly be supposed to take its place is some cold-blooded and dispassionate judicial sentence confined entirely to the intellectual realm, to the effect that a certain person or persons merit chastisement for their sins. In like manner of grief: what would it be without its tears, its sobs, its suffocation of the heart, its pang in the breast-bone? A feelingless cognition that certain circumstances are deplorable, and nothing more. Every passion in turn tells the same story. A purely disembodied human emotion is a nonentity. I do not say that it is a contradiction in the nature of things, or that pure spirits are necessarily condemned to cold intellectual lives; but I say that for *us*, emotion dissociated from all bodily feeling is inconceivable. The more closely I scrutinize my states, the more persuaded I become that whatever moods, affections, and passions I have are in very truth constituted by, and made up of, those bodily changes which we ordinarily call their expression or consequence; and the more it seems to me that if I were to become corporeally anaesthetic, I should be excluded from the life of the affections, harsh and tender alike, and drag out an existence of merely cognitive or intellectual form. Such an existence, although it seems to have been the ideal of ancient sages, is too apathetic to be keenly sought after by those born after the revival of the worship of sensibility, a few generations ago.

B[1]

BY CARL GEORG LANGE

If a clear understanding of relations which I have discussed above is to be made possible, we must, I think, put the facts in the following form: We have in every emotion as sure and tangible factors: (1) a cause—a sensory impression which usually is modified by memory or a previous associated image; and (2) an effect—namely, the above mentioned vaso-motor changes and consequent changes in bodily and mental functions. And now we have the question: What lies between these two factors; or does anything lie between them? If I start to tremble when I am threatened with a loaded pistol, does a purely mental process arise, fear, which is what causes my trembling, palpitation of the heart, and confusion; or are these bodily phenomena aroused immediately by the frightening cause, so that the emotion consists exclusively of these functional disturbances of the body?

The answer to this question is obviously not only of far-reaching significance in the psychology of the affections, but also of the greatest practical importance for every physician who has anything to do with the pathological results of violent emotions.

The popular opinion seems to be that, as has been mentioned, the immediate outcome of a situation which arouses an emotion is a purely psychic one, that is, either a new power is generated in the mind, or a modification of the mental condition takes place; and furthermore, that this mental activity is the actual affection, the real pleasure, pain, etc., whereas the physical phenomena are merely secondary, always present, to be sure, but in themselves quite unessential.

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[1] Taken from *op. cit.*, by James and Lange, pp. 63–72.

The purely mental affection is a hypothesis and, like every hypothesis, is justified only if (1) it explains the phenomena it is assumed to explain, and (2) it is necessary for the explanation of these phenomena.

In regard to the first of the above requirements, the questionable hypothesis has as good chances as any hypothesis of speculative science. Without objections being offered by experience, hypotheses can be broadened at will and they can be endowed with any attribute or power, and consequently they serve any purpose which may be required of them. Can mental fear explain why we turn pale and tremble? Even though we do not understand that, we are free to assume it to be true, and as a rule that is sufficient for us.

If the hypothesis of the psychical nature of the affections, therefore, is indisputable in this point, especially because it lies outside of the realm of proof, the question arises whether it fulfills the second requirement; to be necessary for the explanation of that group of phenomena which we call affections, so that they cannot be understood without its help.

If anyone were to dispute it, if, for example, some one attempted to prove to a man who has grown up with the popular conception of this problem that when he is frightened, his fear is only a perception of the changes in his body, he would very probably meet with the following objection first:—"The assumption of this relation is disproved by personal experience, for fear, like every emotion, has a distinct sensation of a peculiar change, a specific condition of the mind, quite independent of the body." I can well understand how this objection may appear very significant to most people, and be difficult to refute, and yet it has obviously no value whatever, in and for itself, since we have absolutely no immediate means of differentiating between a sensation of mental and one of physical nature. No man, in fact, is capable of differentiating between a sensation of mental and one of physical nature. No man, in fact, is capable of differentiating between psychical and somatic feelings. Whoever attributes a sensation to the mind, does so only on basis of theory, not on basis of immediate perception. I have no doubt that a mother who mourns the death of her child would resent, yes, be indignant, if any one were to tell her that what she feels: the weariness and laxity of her muscles, the coldness of her bloodless skin, the impossibility of her brain to concentrate in clear quick thought; may be attributed to an image of the cause of these phenomena. But this is no ground for indignation, for her feeling is just as strong, just as deep and pure, if attributed to one as to the other cause. It cannot exist, however, without its physical attributes.

Take away the bodily symptoms from a frightened individual; let his pulse beat calmly, his look be firm, his color normal, his movements quick and sure, his speech strong, his thoughts clear; and what remains of his fear?

EXERCISE

1. Formulate in fifty words that view of the emotions advocated by James and Lange.

4. COMMENTS ON THE JAMES-LANGE THEORY

A[1]

BY TH. A. RIBOT

The only point in which I differ from these authors[2] relates to their way of putting the proposition, not to its substance.

It is evident that our two authors, whether consciously or not, share the dualist point of view with the common opinion which they are combating; the only difference being in the interversion of cause and effect. Emotion is a cause of which the physical manifestations are the effect, says one party; the physical manifestations are the cause of which emotion is the effect, says the other. In my view, there would be a great advantage in eliminating from the question every notion of cause and effect, every relation of causality, and in substituting for the dualistic position a unitary or monistic one. The Aristotelian formula of matter and form seems to me to meet the case better, if we understand by "matter" the corporeal facts, and by "form" the corresponding psychical state: the two terms, by-the-bye, only existing in connection with each other and being inseparable except as abstract conceptions. It was traditional in ancient psychology to study the relations of "the soul and the body"—the new psychology does not speak of them. In fact, if the question takes a metaphysical form, it is no longer psychology; if it takes an experimental form, there is no reason to treat it separately, because it is treated in connection with everything. No state of consciousness can be dissociated from its physical conditions: they constitute a natural whole, which must be studied as such. Every kind of emotion ought to be considered in this way: all that is objectively expressed by movements of the face and body, by vaso-motor, respiratory, and secretory disturbances, is expressed subjectively by correlative states of consciousness, classed by external observation according to their qualities. It is a single occurrence expressed in two languages. We have previously assimilated the emotions to psycho-physiological organisms; this unitary point of view, being more conformable to the nature of things and to the present tendencies of psychology, seems to me, in practice, to eliminate many objections and difficulties.

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[1] Taken from *The Psychology of the Emotions*, pp. 111–12. "The Contemporary Science Series," Walter Scott Publishing Co., Ltd., London, 1906.

[2] James and Lange.—Editors.

Whether we adopt this theory or not, we have in any case acquired the certainty that the organic and motor manifestations are not accessories, that the study of them is part of the study of emotion.

B[1]

BY CHARLES S. SHERRINGTON

To obtain some test of the James-Lange theory is not difficult by experiment. Appropriate operation removes completely and immediately the sensation of the viscera and of all the skin and muscles behind the shoulder. The procedure at the same time cuts from connection with the organs of consciousness the whole of the circulatory apparatus of the body. I have had under observation dogs in which this has been carried out. I will cite an animal selected because of markedly emotional temperament. Affectionate toward the laboratory attendants, one of whom had her in charge, toward some persons and toward several inmates of the animal house she frequently showed violent anger. Her ebullitions of rage were sudden. Their expression accorded with a description furnished by Darwin. Besides the utterance of the growl, "the ears are pressed closely backwards, and the upper lip is retracted out of the way of the teeth, especially of the canines." The mouth was slightly opened and lifted, the eyelids widely parted, the pupils dilated. The hair along the middorsum, from close behind the head to a point more than halfway down the trunk, became rough and bristling.

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[1] Adapted from *The Integrative Action of the Nervous System*, pp. 259–66. New Haven: Yale University Press, 1906.

The reduction of the field of sensation in this animal by the procedure above mentioned produced no obvious diminution of her emotional character. Her anger, her joy, her disgust, and when provocation arose, her fear, remained as evident as ever. Her joy at the approach or notice of the attendant, her rage at the intrusion of a cat with which she was unfriendly, remained as active and thorough. But among the signs expressive of rage the bristling of the coat along the back no longer occurred. On the other hand, the eyes were well opened and the pupils distinctly dilated in the paroxysm of anger.

The coming of a visitor whose advent months before had elicited violent anger, again provoked an exhibition of wrath significant as ever. The expression was that of aggressive rage. The animal followed each movement of the stranger as though of an opponent, growling viciously. A cat with which she was never friendly, and a monkey new to the laboratory, approaching too near the kennel, excited similar outbursts. No doubt was left in our minds that sudden attacks of violent anger were still easily excited. But she also gave evidence daily that she had the accession of joyous pleasure and delight she had always shown at the approach of the attendant the first thing of a morning, or at feeding time, or when caressed by him, or encouraged by his voice.

Few dogs, even when very hungry, can be prevailed upon to touch dog's flesh as food. Almost all turn from it with signs of repugnance and dislike. I had strictly refrained from testing this animal previously with regard to disgust at dog's flesh offered in her food. Flesh was given her daily in a bowl of milk, and this she took with relish. The meat was cut into pieces rather larger than the lumps of sugar usual for the breakfast table. It was generally horse-flesh, sometimes ox-flesh. We proceeded to the observation thus: the bowl was placed by the attendant in the corner of the stall with milk and meat in every way as usual; but the meat was flesh from a dog killed on the previous day. Our animal eagerly drew itself toward the food; it had seen the other dogs fed, and evidently was itself hungry. Its muzzle had almost dipped into the milk before it suddenly seemed to find something there amiss. It hesitated, moved its muzzle about above the milk, made a venture to take a piece of the meat, but before actually seizing it stopped short and withdrew again from it. Finally, after some further examination of the contents of the bowl (it usually commenced by taking out and eating the pieces of meat), without touching them, the creature turned away from the bowl and withdrew itself to the opposite side of the cage. Some minutes later, under encouragement from us to try the food again, it returned to the bowl. The same hesitant display of conflicting desire and disgust was once more gone through. The bowl was then removed by the attendant, emptied, washed, and horse-flesh similarly prepared and placed in a fresh quantity of milk was offered in it to the animal. The animal once more drew itself toward the bowl, and this time began to eat the meat, soon emptying the dish. To press the flesh upon our animal was of no real avail on any occasion; the coaxing only succeeded in getting her to, as it were, re-examine but not to touch the morsels. The impression made on all of us by the dog's behavior was that something in the dog's flesh was repulsive to her, and excited disgust unconquerable by ordinary hunger. Some odour attaching to the flesh seemed the source of its recognition.

It would be instructive for judging the part played by the cerebral hemisphere in the reactions of coarser emotion did we know whether repugnance to dog's flesh as food would be exhibited by a dog after ablation of the cerebral hemispheres. Even the primitive emotions seem to involve perception—seem little other than sense-perceptions richly suffused with affective tone. Goltz's dogs after ablation of the hemispheres evinced signs of hunger, namely restlessness when their feeding hour was deferred. When a little quinine (bitter) was added to the sop of meat and milk the morsels taken into the mouth were at once rejected. No inducement or scolding modified this unfailing and unhesitating rejection. Goltz adds that he threw to his own house dog a piece of the same doctored meat. The creature wagged its tail and took it eagerly, then pulled a wry face, and hesitated, astonished. But on a look of encouragement from its master the dog swallowed it. He overcame his instinctive rejection of it, and thus, as Goltz remarks, by his self-control gave proof of the intact cerebrum he possessed.

Fear appeared clearly elicitable (as also in dogs with spinal cervical transection only). The attendant approaching from another room of which the door stood open, chid the dog in high scolding tones. The creature's head sank, her gaze turned away from her advancing master, and her face seemed to betray dejection and anxiety. The respiration became unquiet, but the pulse never changed its rate.

In the dog, after transection of the spinal cord, the regions of the body which have been thus made purely "spinal" continue their life in many respects normally. The hairy "coat" changes in spring. The oestral periods recur even when the transection is performed in puppyhood, and altogether headward of the spinal origin of the sympathetic system, e.g. at the cervical segment. Goltz observed successful impregnation and parturition, and suckling completed without obvious abnormality. In my own observations the natural instinct of the female toward the male at oestrum was seen indubitably displayed after the spinal cord had been transacted in the cervical region more than a year previously.

It may be objected to these experiments that although the animals expressed emotion they may yet have *felt* none. Had their expression been unaccompanied by, and had they not led on to, trains of acts logically consonant with their expressed emotion, that objection would have weight. Where the *facies* of anger is followed by actions of advance and attack with all appearance of set purpose, I find it difficult to think that the perception initiating the wrathful expression should bring in sequel angry conduct and yet have been impotent to produce "angry feeling."

A weaker point in such experimentation is that although the visceral and vascular and much of the muscular mechanism of emotional expression was cut off, a small but notable fraction of the latter, namely the facial, still remained open to react on the centres with which consciousness is colligate.

Nevertheless, in view of these observations the vasomotor theory of the production of emotion becomes, I think, untenable, also that visceral sensations or presentations are *necessary* to emotion. A mere remnant of all the non-projecting or effective senses was left, and yet emotion persisted. If I understand it aright, Professor James' and Lange's theory lays stress on organic and visceral presentations, but re-presentations of the same species might no doubt be put forward in their place. That would be a different matter. To exclude the latter hypothesis, the deprivation of vascular and organic sensation might have to date from a very early period of the individual life. Professor Lloyd Morgan writes in respect to the above experiments, "The avenues of connection were closed *after* the motor and visceral effects had played their part in the *genesis* of the emotion on the hypothesis that the emotion is thus generated. Although new presentative data of this type were thus excluded, their re-presentative after-effects in the situation were not excluded." But it is noteworthy that one of the dogs under observation had been deprived of its sensation when only nine weeks old. Disgust for dog's flesh could hardly arise from the experience of nine weeks of puppyhood in the kennel.

We are forced back toward the likelihood that the visceral expression of emotion is *secondary* to the cerebral action occurring with the psychical state. There is a strong bond between emotion and muscular action. Emotion "moves" us, hence the word itself. If developed in intensity, it impels toward vigorous movement. Every vigorous movement of the body, though its more obvious instrument be the skeletal musculature of the limbs and trunk, involves also the less noticeable co-operation of the viscera, especially of the circulatory and respiratory. The extra demand made upon the muscles that move the frame involves a heightened action of the nutrient organs which supply to the muscles the material for their energy. This increased action of the viscera is colligate with this activity of muscles. We should expect visceral action to occur along with the muscular expression of emotion. The close tie between visceral action and states of emotion need not therefore surprise us.

C[1]

BY WALTER B. CANNON

Darwin reports the case of a young man who on hearing that a fortune had just been left him, became pale, then exhilarated, and after various expressions of joyous feeling vomited the half-digested contents of his stomach. Müller has described the case of a young woman whose lover had broken the engagement of marriage. She wept in bitter sorrow for several days, and during that time vomited whatever food she took. And Burton, in his *Anatomy of Melancholy*, gives the following instance of the effect of disgust: "A gentlewoman of the same city saw a fat hog cut up, when the entrails were opened, and a noisome savour offended her nose, she much disliked, and would not longer abide; a physician in presence told her, as that hog, so was she, full of filthy excrements, and aggravated the matter by some other loathsome instances, insomuch this nice gentlewoman apprehended it so deeply that she fell forthwith a vomiting, was so mightily distempered in mind and body, that with all his art and persuasion, for some months after, he could not restore her to herself again, she could not forget or remove the object out of her sight."

In these three cases, of intense joy, intense sorrow and intense disgust, the influence of the cranial division of the autonomic nervous system has been overcome, digestion has ceased, and the stagnant gastric contents by reflexes in striated muscles have been violently discharged. The extent to which under such circumstances other effects of sympathetic impulses may be manifested, has not, so far as I know, been ascertained.

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[1] Adapted from *Bodily Changes in Pain, Hunger, Fear and Rage*, pp. 278–80 New York: D. Appleton & Co., 1922.

From the evidence just given it appears that any high degree of excitement in the central nervous system, whether felt as anger, terror, pain, anxiety, joy, grief or deep disgust, is likely to break over the threshold of the sympathetic division and disturb the functions of all the organs which that division innervates. It may be that there is advantage in the readiness with which these widely different emotional conditions can express themselves in this one division, for, as has been shown, occasions may arise when these milder emotions are suddenly transmuted into the naturally intense types (as fright and fury) which normally activate this division; and if the less intense can also influence it, the physiological aspect of the transmutation is already partially accomplished.

If various strong emotions can thus be expressed in the diffused activities of a single division of the autonomic—the division which accelerates the heart, inhibits the movements of the stomach and intestines, contracts the blood vessels, erects the hairs, liberates sugar, and discharges adrenalin—it would appear that the bodily conditions which have been assumed, by some psychologists, to distinguish emotions from one another must be sought for elsewhere than in the viscera. We do not "feel sorry because we cry," as James contended, but we cry because when we are sorry or overjoyed or violently angry or full of tender affection—when any one of these diverse emotional states is present—there are nervous discharges by sympathetic channels to various viscera, including the lachrymal glands. In terror and rage and intense elation, for example, the responses in the viscera seem too uniform to offer a satisfactory means of distinguishing states which in man at least, are very different in subjective quality. For this reason I am inclined to urge that the visceral changes merely contribute to an emotional complex more or less indefinite, but still pertinent, feelings of disturbance in organs of which we are not usually conscious.

D[1]

BY JAMES R. ANGELL

Professor James, so far as I recall, nowhere set himself the task of attempting to differentiate emotions on exactly the basis suggested by Dr. Cannon's statement. Quite the contrary; he says (*Prin-*

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[1] Adapted from "A Reconsideration of James's Theory of Emotion in the Light of Recent Criticisms," *Psychological Review*, XXIII (1916), 259–61.

ciples, Volume II, p. 454): "Now the moment the genesis of an emotion is accounted for, as the arousal by an object of a lot of reflex acts which are forthwith felt, we immediately see why there is no limit to the number of possible different emotions which may exist, and why emotions of different individuals may vary indefinitely both as to their constitution and to the objects which call them forth. For there is nothing sacramental or eternally fixed in reflex action. Any reflex effect is possible, and reflexes actually vary indefinitely, as we know." That there are marked differences even in the visceral processes is perhaps sufficiently suggested by Pavlov's classical experiments on the flow of gastric juice which is provoked by hunger coupled with pleasurable emotion, and checked by fear or rage. This checking by fear and also by rage is cited by Cannon as an instance of an identical visceral reaction occasioned by different emotions, because, as he says, "These emotions accompany organic preparations for action and . . . . because the conditions which evoke them are likely to result in flight or conflict." James himself, it should be added, regards these two emotions as very similar and closely related.

James would certainly have to hold that, however much emotions may vary in their expression in different individuals and in the same individual, when *all* the reflex effects were taken into account, distinguishable emotions would always have variant bodily expressions. But this does not by any means preclude a considerable matrix of substantially identical visceral excitement for some different emotions. Their distinction from one another in such cases may be found in extra-visceral conditions, and particularly in the tonus of the skeletal muscles. Fear and joy may both cause cardiac palpitation, but in one case we find high tonus of the skeletal muscles, in the other case relaxation and the general sense of weakness. Many other illustrations of the same sort of thing will suggest themselves.

We would therefore submit that, so far as concerns the critical suggestions of Cannon and Sherrington, James's essential contentions are not materially affected. That the instinctive impulses in the head segment of the dog should be literally unaffected by the removal of the central connections with the viscera is striking evidence of the physiological independence of this anterior segment; but it certainly affords no evidence that visceral organic sensations of human beings play no part in emotional psychoses—a conclusion which Sherrington does not draw in this extreme form, but which careless readers have so drawn and which is flagrantly at variance with daily experience.[1] Nor does it prove in any way that the psychic state dubbed "emotion" precedes its "physiological expressions" so-called, a view for which Sherrington declares his preference. It is consonant with such a view, but also with James's view. Moreover, so far as the animals may be supposed to have been conscious of the reaction of the facial and fore-limb muscles, they had a good bit of the basis of the psychic stuff which James is always presenting, in season and out, as among the most essential features in our awareness of the self. In other words, no evidence which left facial and cranial muscles unimpaired would ever have seemed to him very convincing as ground for conclusions unfavorable to his theory. And as to the classification of emotion, he was a latitudinarian, holding that many groupings were possible and significant. To group on the basis of visceral reactions alone would presumably have seemed to him theoretically possible, but quite unimportant for any penetrating apprehension of the total situation, because disregarding a full half, and perhaps more, of the important organic reactions, to wit, the general peripheral and skeletal conditions.

E[2]

BY WALTER B. CANNON

A CONSIDERATION OF THE VISCERAL FACTORS

The backflow of impulses from the periphery, on which James relied to account for the richness and variety of emotional feeling, was assumed to arise from all parts of the organism, from the muscles and skin as well as the viscera. To the latter, however, he inclined to attribute the major rôle—on "the visceral and organic part of the expression," he wrote, "it is probable that the chief part of the felt emotion depends." We may distinguish, therefore, his two sources of the afferent stream. We shall first consider critically the visceral source. In connection therewith we shall comment on Lange's idea that the vasomotor center holds the explanation of emotional experience.

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[1] The retention of the expressions of rage in decerebrate dogs suggests the extent to which instinctive motor phenomena may be preserved in the presence of operative injury which might well be supposed to disintegrate all emotional phenomena, and especially in view of the fact that in such animals other emotional expressions are practically abolished.

[2] Taken from material to appear in chapter xviii of the second edition of *Bodily Changes in Pain, Hunger, Fear and Rage.* New York: D. Appleton & Co., 1929. The material quoted here appeared in the Washburn Commemorative Volume of the *American Journal of Psychology*, 1927, pp. 107–19.

The student can obtain bibliographical references to the studies cited in this selection by going to Professor Cannon's actual text.—EDITORS.

(1) *Total separation of the viscera from the central nervous system does not alter emotional behavior.* Sherrington transected the spinal cord and the vagus nerves of dogs so as to destroy any connection of the brain with the heart, the lungs, the stomach and the bowels, the spleen, the liver, and other abdominal organs—indeed, to isolate all the structures in which formerly feelings were supposed to reside. Recently Cannon, Lewis, and Britton have succeeded in keeping cats in a healthy state for many months after removal of the entire sympathetic division of the autonomic system, the division which operates in great excitement. Thus all vascular reactions controlled by the vasomotor center were abolished; secretion from the adrenal medulla could no longer be evoked; the action of the stomach and intestines could not be inhibited, the hairs could not be erected, and the liver could not be called upon to liberate sugar into the blood-stream. These extensively disturbing operations had little if any effect on the emotional responses of the animals. In one of Sherrington's dogs, having a "markedly emotional temperament," the surgical reduction of the sensory field caused no obvious change in her emotional behavior; "her anger, her joy, her disgust, and when provocation arose, her fear, remained as evident as ever." And in the sympathectomized cats all superficial signs of rage were manifested in the presence of a barking dog—hissing, growling, retraction of the ears, showing of the teeth, lifting of the paw to strike—*except* erection of the hairs. Both sets of animals behaved with full emotional expression in all the organs still connected with the brain; the only failure was in organs disconnected. The absence of reverberation from the viscera did not alter in any respect the appropriate emotional display; its only abbreviation was surgical.

As Sherrington has remarked, with reference to his head-and-shoulder dogs, it is difficult to think that the perception initiating the wrathful expression should bring in sequel angry conduct and yet have been impotent to produce "angry feeling."

At this point interpretations differ. Angell has argued that Sherrington's experiments afford no evidence that visceral sensation plays no part in the emotional psychosis, and further that they do not prove that the psychic state, "emotion," precedes its "expression." And

Perry has declared that whether in the absence of sensations from the organs surgically isolated, the emotion is *felt* remains quite undecided.

It must be admitted, of course, that we have no real basis for either affirming or denying the presence of "felt emotion" in these reduced animals. We have a basis, however, for judging their relation to the James-Lange theory. James attributed the chief part of the felt emotion to sensations from the viscera; Lange attributed it wholly to sensations from the circulatory system. Both affirmed that if these organic sensations are removed *imaginatively* from an emotional experience nothing is left. Sherrington and Cannon and his collaborators varied this procedure by removing the sensations *surgically*. In their animals all visceral disturbances through sympathetic channels—the channels for nervous discharge in great excitement—were abolished. The possibility of return impulses by these channels, and in Sherrington's animals by vagus channels as well, were likewise abolished. According to James's statement of the theory the felt emotion should have very largely disappeared, and according to Lange's statement it should have wholly disappeared (without stimulation of our vasomotor system, it will be recalled, impressions of the outer world "would arouse neither joy nor anger, would give us neither care nor fear"). The animals *acted*, however, insofar as nervous connections permitted, with no lessening of the intensity of emotional display. In other words, operations which, in terms of the theory, largely or completely destroy emotional feeling, nevertheless leave the animals behaving as angrily, as joyfully, as fearfully as ever.

(2) *The same visceral changes occur in very different emotional states and in non-emotional states.* The preganglionic fibers of the sympathetic division of the autonomic system are so related to the outlying neurones that the resulting innervation of smooth muscles and glands throughout the body is not particular but diffuse. At the same time with the diffuse emission of sympathetic impulses adrenin is poured into the blood. Since it is thereby generally distributed to all parts and has the same effects as the sympathetic impulses wherever it acts, the humoral and the neural agents co-operate in producing diffuse effects. In consequence of these arrangements the sympathetic system goes into action as a unit—there may be minor variations as, for example, the presence or absence of sweating, but in the main features integration is characteristic.

The visceral changes wrought by sympathetic stimulation may be listed as follows: acceleration of the heart, contraction of arterioles, dilatation of bronchioles, increase of blood sugar, inhibition of activity of the digestive glands, inhibition of gastro-intestinal peristalsis, sweating, discharge of adrenin, widening of the pupils, and erection of hairs. These changes are seen in great excitement under any circumstances. They occur in such readily distinguishable emotional states as fear and rage. Fever and also exposure to cold are known to induce most of the changes—certainly a faster heart rate, vasoconstriction, increased blood sugar, discharge of adrenin, and erection of the hairs. Asphyxia at the stimulating stage evokes all the changes enumerated above, with the possible exception of sweating. A too great reduction of blood sugar by insulin provokes the "hypoglycemic reactions"—characterized by pallor, rapid heart, dilated pupils, discharge of adrenin, increase of blood sugar and profuse sweating.

In this group of conditions which bring about in the viscera changes which are typical of sympathetic discharge are such intense and distinct emotions as fear and rage, such relatively mild affective states as those attending chilliness, hypoglycemia and difficult respiration, and such a markedly different experience as that attending the onset of fever. As pointed out earlier by Cannon, the responses in the viscera seem too uniform to offer a satisfactory means of distinguishing emotions which are very different in subjective quality. Furthermore, if the emotions were due to afferent impulses from the viscera, we should expect not only that fear and rage would feel alike but that chilliness, hypoglycemia, asphyxia, and fever should feel like them. Such is not the case.

In commenting on this criticism of the James-Lange theory Angell admits that there may be a considerable matrix of substantially identical visceral excitement for some emotions, but urges that the differential features may be found in the extra-visceral disturbances, particularly in the differences of tone in skeletal muscles. Perry likewise falls back on the conformation of the proprioceptive patterns, on the "motor set" of the expression, to provide the distinctive elements of the various affective states. The possible contribution of skeletal muscles to the genesis of the felt emotion will be considered later. At present the fact may be emphasized that Lange derived no part of the emotional psychosis from that source; and James attributed to it a minor rôle—the chief part of the felt emotion depended on the visceral and organic part of the expression.

(3) *The viscera are relatively insensitive structures.* There is a common belief that the more deeply the body is penetrated the more

sensitive does it become. Such is not the fact. Whereas in a spinal nerve trunk the sensory nerve fibers are probably always more numerous than the motor, in the nerves distributed to the viscera the afferent (sensory) fibers may be only one-tenth as numerous as the efferent. We are unaware of the contractions and relaxations of the stomach and intestines during digestion, of the rubbing of the stomach against the diaphragm, of the squeezing motions of the spleen, of the processes in the liver—only after long search have we learned what is occurring in these organs. Surgeons have found that the alimentary tract can be cut, torn, crushed or burned in operations on the unanesthetized human subject without evoking any feeling of discomfort. We can feel the thumping of the heart because it presses against the chest wall, we can also feel the throbbing of blood vessels because they pass through tissues well supplied with sensory nerves, and we may have abdominal pains but apparently because there are pulls on the parietal peritoneum. Normally the visceral processes are extraordinarily undemonstrative. And even when the most marked changes are induced in them, as when adrenalin acts, the results, as we shall see, are sensations mainly attributable to effects on the cardiovascular system.

(4) *Visceral changes are too slow to be a source of emotional feeling.* The viscera are composed of smooth muscle and glands except the heart, which is modified striate muscle. The motions of the body with which we are familiar result from quick-acting striate muscle, having a true latent period of less than 0.001 sec. Notions of the speed of bodily processes acquired by observing the action of skeletal muscle we should not apply to other structures. Smooth muscle and glands respond with relative sluggishness. Although Stewart found that the latent period of smooth muscle of the cat was about 0.25 sec., Sertoli observed that it lasted for 0.85 sec. in the dog and 0.8 sec. in the horse. Langley reported a latent period of 2 to 4 secs. on stimulating the *chorda tympani* nerve supply to the submaxillary salivary gland; and Pawlow a latent period of about 6 *minutes* on stimulating the vagus, the secretory nerve of the gastric glands. Again, Wells and Forbes noted that the latent period of the psychogalvanic reflex (in man), which appears to be a glandular phenomenon, was about 3 secs.

In contrast to these long delays before peripheral action in visceral structures barely starts are the observations of Wells; he found that the latent period of affective reactions to pictures of men and women ended not uncommonly within 0.8 sec. More recent studies with odors as stimuli have yielded a similar figure (personal communication). According to the James-Lange theory, however, these affective reactions result from reverberations from the viscera. But how is that possible? To the long latent periods of smooth muscles and glands, cited above, there must be added the time required for the nerve impulses to pass from the brain to the periphery and thence back to the brain again. It is clear that the organic changes could not occur soon enough to be the occasion for the appearance of affective states, certainly not the affective states studied by Wells.

(5) *Artificial induction of the visceral changes typical of strong emotions does not produce them.* That adrenin, or the commercial extract of the adrenal glands, "adrenalin," acts in the body so as to mimic the action of sympathetic nerve impulses has already been mentioned. When injected directly into the blood stream or under the skin it induces dilation of the bronchioles, constriction of blood vessels, liberation of sugar from the liver, stoppage of gastro-intestinal functions, and other changes such as are characteristic of intense emotions. If the emotions are the consequence of the visceral changes we should reasonably expect them, in accordance with the postulates of the James-Lange theory, to follow these changes in all cases. Incidental observations on students who received injections of adrenalin sufficiently large to produce general bodily effects have brought out the fact that no specific emotion was experienced by them—a few who had been in athletic competitions testified to feeling "on edge," "keyed up," just as before a race. In a careful study of the effects of adrenalin on a large number of normal and abnormal persons Marañon has reported that the subjective experiences included sensations of precardial or epigastric palpitation, of diffuse arterial throbbing, of oppression in the chest and tightness in the throat, of trembling, of chilliness, of dryness of the mouth, of nervousness, malaise and weakness. Associated with these sensations there was *in certain cases* an indefinite affective state coldly appreciated, and without real emotion. The subjects remarked, "I feel as if afraid," as if awaiting a great joy," "as if moved," "as if I were going to weep without knowing why," "as if I had a great fright yet am calm," "as if they are about to do something to me." In other words, as Marañon remarks, a clear distinction is drawn "between the perception of the peripheral phenomena of vegetative emotion (*i.e.* the bodily changes) and the psychical emotion proper, which does not exist and which permits the subjects to report on the vegetative syndrome with serenity, without true feeling." In a smaller number of the affected cases a real emotion developed, usually that of sorrow, with tears, sobs and sighings. This

occurs, however, "only when the emotional predisposition of the patient is very marked," notably in hyperthyroid cases. In some instances Marañon found that this state supervened only when the adrenal was injected after a talk with the patients concerning their sick children or their dead parents. In short, only when an emotional mood already exists does adrenalin have a supporting effect.

From the evidence adduced by Marañon we may conclude that adrenalin induces in human beings typical bodily changes which are reported as sensations, that in some cases these sensations are reminiscent of previous emotional experiences but do not renew or revive those experiences, that in exceptional cases of preparatory emotional sensitization the bodily changes may tip the scales towards a true affective disturbance. These last cases are exceptional, however, and are not the usual phenomena as James and Lange supposed. In normal conditions the bodily changes, though well marked, do not provoke emotion.

The numerous events occurring in the viscera in consequence of great excitement, as detailed by Cannon, have been interpreted as supporting the James-Lange theory. From the evidence presented under the five headings above it should be clear that that interpretation is unwarranted. Since visceral processes are fortunately not a considerable source of sensation, since even extreme disturbances in them yield no noteworthy emotional experience, we can further understand now why these disturbances cannot serve as a means for discriminating between such pronounced emotions as fear and rage, why chilliness, asphyxia, hyperglycemia and fever, though attended by these disturbances, are not attended by emotion, and also why total exclusion of visceral factors from emotional expression makes no difference in emotional behavior. It is because the returns from the thoracic and abdominal "sounding-board," to use James's word, are very faint indeed, that they play such a minor rôle in the affective complex. The processes going on in the thoracic and abdominal organs are truly remarkable and various; their value to the organism, however, is not to add richness and flavor to experience but rather to adapt the internal economy so that in spite of shifts of outer circumstance the even tenor of the inner life will not be profoundly disturbed.

A CONSIDERATION OF THE POSTURAL FACTORS

In his discussion of the cerebral processes accompanying emotion, James argued that either there were special centers for them or they occurred in the ordinary motor and sensory centers of the cortex.

And if in the ordinary centers, according to his postulate, the processes would resemble the ordinary processes attending sensation. Only that and full representation of each part of the body in the cortex would be needed to provide a scheme capable of representing the *modus operandi* of the emotions. Object—sense organ—cortical excitation—perception—reflexes to muscle, skin, and viscus-disturbances in them—cortical excitation by these disturbances—perceptions of them added to the original perceptions; such are the occurrences which result in the "object-emotionally-felt." The strict alternative, however, of cortical processes *or* special centers we need not accept. There may be cortical processes *and* special centers. Whether such is the arrangement we may now consider.

(1) *Emotional expression results from action of subcortical centers.* In a paper published in 1887, Bechterev argued that emotional expression must be independent of the cortex because at times the expression cannot be inhibited (*e.g.* laughing from tickle, grinding the teeth and crying from pain), because visceral changes occur which are beyond control, and because it is seen just after birth before cortical management is important. Furthermore, he reported that after removing the cerebral hemispheres from various kinds of animals appropriate stimulations would evoke corresponding responses of an effective character. Noxious stimuli would cause the hemisphereless cats to snarl, the dogs to whine, to show their teeth and to bark; gentle stimuli (stroking the back) would cause the cats to purr and the dogs to wag their tails. Since these effects disappeared when the optic thalamus was removed, he drew the conclusion that it plays a predominant rôle in emotional expression.

In 1904 Woodworth and Sherrington proved that many of the physiological phenomena of great excitement would appear in cats from which the thalamus had been wholly removed by section of the brainstem at the mesencephalon. Strong stimulation of an afferent nerve was required to evoke the "pseudaffective" responses. Although these observations tended to lessen the importance of the thalamus as a center, recent experiments have again emphasized its dominance. In 1925 Cannon and Britton described a pseudaffective preparation—a cat decorticated under ether anesthesia—which on recovery displayed spontaneously the complete picture of intense fury. Further study by Bard (work still unpublished) showed that this sham rage continued after ablation of all the brain anterior to the diencephalon. Only when the lower posterior portion of the thelamic region was removed did the extraordinary activities of the preparation subside. These results clearly point to the thalamus as a region from which, in the absence of cortical government, impulses are discharged which evoke an extreme degree of "emotional" activity, both muscular and visceral.

The evidence just cited is confirmed by observations on human beings. As has been pointed out elsewhere when the cortical processes are abolished by anesthesia, emotional display may be most remarkable. During the early (excitement) stage of ether anesthesia, for example, there may be sobbing as in grief, or laughter as in joy, or lively and energetic aggressive actions as in rage. The surgeon may open the chest or perform other operations of equal gravity, while the patient is pushing, pulling, shouting, and muttering; a few minutes later the conscious patient will testify that he has been wholly unaware of what has happened. It is when "laughing gas" has set aside the cortical functions that the subjects laugh and weep. Similar release of the mechanisms for emotional expression is indicated in the depression of cortical activity during acute alcoholism. In all these conditions the drug acts first as a depressant on the highly sensitive cells of the cortex, and thus lessens or temporarily destroys their control of lower centers; only when the drug becomes more concentrated does it depress also the lower centers; but before that stage is reached the lower centers, released from the cortical dominance as in the surgically decorticated animals, show forth their functions in free play.

Consistent with the experimental and pharmacological evidence is the evidence derived from pathological cases. In certain forms of hemiplegia the patients may be incapable of moving the face on the paralyzed side; if suddenly they are affected by a sorrowful or joyous emotion, however, the muscles, unresponsive to voluntary control, spring into action and give both sides of the face the expression of sadness or gaiety. These cases occur when the motor tract is interrupted subcortically and the optic thalamus is left intact. The opposite of this condition is seen in unilateral injury of the thalamus. A patient described by Kirilzev moved symmetrically both sides of his face at will, but when he laughed in fun or made a grimace in pain the right side remained motionless; at autopsy a tumor was found in the center of the left optic thalamus. This localization of the central neural apparatus for the expressions of pleasure and pain has interesting relations to emotive phenomena commonly seen in so-called "pseudo-bulbar palsy." In such cases there is usually a bilateral facial paralysis, with one side slightly more involved than the other. Voluntary pursing of the lips as in whistling, or wrinkling of the forehead, or making a grimace may be impossible. The intractable facial muscles, however, function normally in laughing or crying, scowling or frowning. These well-executed expressions come in fits and are uncontrollable and prolonged. One patient is described who started laughing at 10:00 o'clock in the morning and continued with few pauses until 2:00 in the afternoon! Tilney and Morrison, who have reported on 173 recorded cases of the disease, found such fits of crying and laughing in seventeen percent of the cases, crying alone in sixteen percent, and laughing alone in fifteen percent. The fits appear as a rule without any of the usual provocations and most frequently are inopportune. The patient may have all the appearances of being convulsed with laughter, yet may not experience any of the feeling which the motions of face and body indicate. Such cases are attributed by Brissaud to lesions of a special part of the cortico-thalamic tract which free a portion of the thalamus from the cortical check. It seems probable, as later evidence will suggest, that afferent thalamo-cortical tracts are also defective. Finally, cases of "narcolepsy" are known in which emotional expression is nearly nil; gibes and insults which enrage or infuriate the normal person are usually quite without effect. In some of these cases, examined *post-mortem*, were found tumors on the under side of the diencephalon, often affecting the whole hypothalamus.

All these observations, experimental and clinical, consistently point to the optic thalamus as a region in which resides the neural organization for the different emotional expressions. The section in James's discussion, headed "No Special Brain Centres for Emotion" must be modified in the light of this accumulated information. The cortex at one end of the nerve paths as a reflex surface and the peripheral organs at the other end as a source of return impulses make too simple an arrangement. Between the cortex and the periphery lies the diencephalon, an integrating organ on the emotive level, a receiving and discharging station, that on proper stimulation is capable of establishing in stereotyped forms the facies and bodily postures typical of the various affective states. That all afferent paths leading toward the cortex have relays in the diencephalon is a fact of great significance in explaining the nature of emotions.

(2) *Thalamic processes are a source of affective experience.* The relaying of all sensory neurones in some part of the optic thalamus has been stressed by Head in his important clinical studies. He and Holmes

attributed to this region a sort of consciousness, an "awareness." The effect of anesthesia in abolishing consciousness while leaving emotional expression (thalamic in origin) undisturbed would seem to contradict this view. But even if consciousness is associated only with events in cortical neurones, the important part played by thalamic processes is little disturbed thereby. The relays of sensory channels in the thalamus and the evidence that disturbances in that region are the occasion for intensely affective sensations are all that we need for understanding its relation to the nature of emotions.

Head has cited numerous cases of unilateral lesions in the thalamic region in which there is a marked tendency to react excessively to affective stimuli; pin-pricks, painful pressure, excessive heat or cold, all produce more distress on the damaged than on the normal side of the body. Agreeable stimuli also are felt keenly on the damaged side; warmth stimuli may evoke intense pleasure, attended by signs of enjoyment on the face and exclamations of delight. Again, affective stimuli, such as the playing of music and the singing of hymns, may arouse such increased emotional feeling on the damaged side that they may be intolerable. Affective conscious states have an influence on the damaged side similar to stimuli from the surface receptors. This extravagant influence of affective stimuli, whether from above or below, Head attributed to release of the thalamus from cortical inhibition. It is not an irritative effect, he argued, because it persists for long periods, well after all the disturbances due to the injury have subsided. And since the affective states are increased when the thalamus is freed from cortical control, Head's conclusion is that the essential thalamic center is mainly occupied with the affective side of sensation.

We are now in a position to consider the evidence that the positions and tensions of skeletal muscle make the differentia of emotion. It will be recalled that, although James belittled this element in his theory, his supporters have stressed it, especially since the visceral element proved inadequate. The thalamic cases provide a means of testing the contribution from skeletal muscles, for the feeling-tone of a sensation is a product of thalamic activity, and the fact that a sensation is devoid of feeling-tone shows that the impulses which underlie its production make no thalamic appeal.

Head found that his patients reported marked differences in the feeling-tone of different sensations. A tuning-fork may have no effect, whereas patriotic music is felt intensely on the damaged side. All thermal stimuli make a double appeal, to the cortex and to the thalamus. Unselected tactile stimuli act similarly. On the other hand, *sensations which underlie the appreciation of posture are entirely lacking in feeling-tone.* Precisely those afferent impulses from muscles and joints which James and his supporters have relied upon to provide the extra-visceral part of the felt emotion are the impulses which lack the necessary quality to serve the purpose! The quality of emotions is to be found, therefore, neither in returns from the viscera nor in returns from the innervated muscles.

EXERCISES

1. Write an essay on the James-Lange theory. The following topics should be considered:
    - *a*) The issues actually involved in the controversy over this theory
    - *b*) The distinction between the points at issue that are largely matters of interpretation and those that are largely matters of fact
    - *c*) Your own conclusions regarding:
        - (1) The correct definition of emotion
        - (2) The validity of the James-Lange theory
2. In light of the foregoing discussion can you see any relationship between a person's bodily health and his emotional life? Can you see how emotional habits might have an effect upon bodily health?
3. Give a list of the facts that seem to indicate the existence of a definite brain center for emotion.

5. EMOTION AS CONFLICT[1]

BY JOHN DEWEY

The familiar fact that emotion as excitement disappears with definiteness of habit simply means that in so far as one activity serves *simply* as means, or cue, to another and gives way at once to it, there is no basis for conflict and for inhibition. But if the stimulating and the induced activities need to be coördinated together, if they are both means contributing to one and the same end, then the conditions for mere habit are denied, and some struggle, with incidental inhibitory deflection of the immediate activity, sets in. In psychological terms, this tension is always between the activity which constitutes, when interpreted, the object as an intellectual content, and that which constitutes the response or mode of dealing with it. There is the one phase of organic activity which constitutes the bear as object; there is the other which would attack it, or run away from it, or stand one's ground before it. If these two coördinate *without friction*, or if one immediately displaces the other, there is no emotional seizure. If they co-exist, both pulling apart as complete in themselves and pulling together as parts of a new whole, there is great emotional excitement.

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[1] Taken from "The Theory of Emotion," *Psychological Review*, II (1885), 26–27.

EXERCISE

1. Show how anger, grief, and joy may arise out of conflicts within the individual.

6. OF THE INNATE BOND CONNECTING THE PRIMARY EMOTIONS[1]

BY ALEXANDER F. SHAND

The most conspicuous of these greater systems of emotion is Love; and in all Love there is an organisation of the lesser systems of many emotions,—as those of fear, anger, joy, and sorrow, besides others. In the presence of anything we love we are disposed to feel joy, and in prolonged absence from it, sorrow, and at the suggestion of danger to feel the fear of losing it, and when it is attacked to feel anger against the assailant. And with regard to the question whether there is any innate basis for such higher organisation, it seems undeniable that all the primary emotions and impulses are innately connected with the emotion of anger. Interference with any one of them tends to evoke a display of anger; and this is how the earliest anger of the child is manifested, as when it is taken away from its toys, or interfered with in other occupations Nor would it be a reasonable assumption that this anger is at first fortuitously aroused by obstruction to some instinct or impulse, and only gradually bound to it by association. The process is too sure and general from the beginning for such an explanation to be plausible. In the second place, the satisfaction of all instincts and impulses tends to be accompanied by some degree of joy or enjoyment, and especially if their satisfaction has been somewhat delayed or obstructed. The occurrence of this enjoyment is no more a fortuitous event on its first happening than was the anger, but seems to be innately connected with the satisfaction of the tendency which preceded it. In the third place, the failure to satisfy any strong primary impulse—not merely the obstruction which arouses anger, but that failure which amounts to frustration—this we have found to be at least one of the primitive causes of sorrow. And it is therefore reasonable to assume that the higher animals, as well as the young child, are susceptible to this primitive sorrow. Anger itself when it is beaten out of an animal, a child, or a man, tends to be replaced by sorrow. The dog, instead of barking, growling, and showing his teeth, yelps; the child bursts into a flood of tears; the schoolboy cries out that he "gives in"; and man himself, his pride broken, appeals for mercy to his enemy, or prostrated by disease and suffering, cries out to an invisible power, "Oh, help me! Have mercy on me!" These are the cries of sorrow, the motor responses of the living system in the situation which has evoked it; and in this situation it is the only emotion which is serviceable, and the one therefore which is normally aroused.

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[1] Adapted by permission from *The Foundations of Character* (2d ed.), pp. 35–38. London: Macmillan Co. Copyrighted, 1920.

Here, then, we must assume that there is some innate connection between the frustrated impulse and sorrow, just as there is between the satisfied impulse and joy.

If we take any other primary impulse or emotion we shall find the same result, as, for instance, hunger, disgust, or the impulses for exercise or repose. According as this impulse or emotion is obstructed, or satisfied, or frustrated, it will elicit anger, joy, or sorrow,—supposing always that it has sufficient strength; for an impulse may be so rapidly superseded that it will have no time to evoke any other emotion.

If, then, any primary emotion will from the outset elicit anger, joy, or sorrow according to the situation in which it operates, the connection between it and them must be innate. For if the conjunction of one with the other were fortuitous in the beginning, and the connection between them only established by association, then in the beginning also we should find uncertainty, and divergent results in different cases, with only at most a progress toward uniformity, instead of uniformity from the beginning.

And, further, any impulse that is strongly working in us may not only arouse anger when obstructed and sorrow when frustrated, but also, when we anticipate its frustration, fear. If we anticipate that hunger will not be satisfied, then in addition to the pangs of hunger we suffer from the fear of starvation. Nor do we only feel this fear because the satisfaction of hunger is a matter of life or death. Any other impulse that is strong enough to persist in the face of opposition may have the same effect. We desire sleep, and people who have had experience of sleeplessness often come to fear it. Only this fear is dependent on ideas, and the ideas on a previous experience, and, therefore, unlike primitive fears, seems to be acquired. Yet once we have formed these ideas of coming disasters, the fear--and not sometimes another, unsuitable emotion—falls into its right place uniformly, as if it were from the beginning fitted for this place. Still such animals as cannot anticipate evils cannot be subject to these fears, but only to those that arise from sensations.

The connection between this fear and the anticipated frustration of some impulse is partly acquired, because this anticipation is due to our previous experience; but it appears also to be partly innate, because once the anticipation is formed and connected with an impulse sufficiently strong and important, the fear will tend to arise from the first with sureness and uniformity.

These four emotional systems of anger, fear, joy, and sorrow seem to have an innate connection not only with every other primary system but also with one another. The frustration of anger provokes a bitter sorrow, its satisfaction a peculiar joy of elation, obstruction to it, increase of anger, and the threatened loss of the sweets of revenge, when anger is deliberate and develops hate, may even excite fear. Joy itself, which, superficially regarded, seems to be without an impulse, yet when it is opposed, provokes anger, and when it is lost, sorrow; and when a great joy comes to us there arises the fear of losing it. Sorrow, too, when its outbursts or its self-absorption and solitary habits are opposed, evokes anger; and when its impulses are frustrated redoubled sorrow; but with relief comes joy. And if extreme sorrow seldom evokes fear—for when our situation cannot be worse, what more have we to fear?—yet when its impulses for help and restoration persist, these may also elicit the fear that they will not prevail. Even fear itself, when its impulse is opposed, may arouse anger, and the coward fleeing from danger will fight one who arrests him; and fear when it is frustrated, and no escape is possible, is combined with sorrow; but when it achieves escape, there is a joyful relief.

There is then evidence of some innate connection between the systems of these four emotions; the precise conditions under which one elicits another are complex and difficult to determine without a prolonged inquiry, but we shall assume that when these conditions are operative the emotion is evoked uniformly, and inevitably from the beginning, and this would not be possible were there not an innate connection between them.

Let us then assume that this law is operative at the base of the higher organisations of character: *Every primary impulse, whether it is independent or belongs to a primary emotion, is innately connected with the systems of fear, anger, joy, and sorrow, in such a way that, when opposed, it tends to arouse anger; when satisfied, joy; when frustrated, sorrow; and when it anticipates frustration, fear; these systems being similarly connected together.* This law must also be understood to imply that there is in the very structure of the nervous system an innate base for the organisation of the dispositions of these primary emotions with one another and with the disposition of any other primary impulse.

EXERCISE

1. Show how fear, anger, joy, and sorrow are organized in patriotism; in honesty.

7. THE DESCRIPTION OF AN EMOTION

A[1]

BY CHARLES DARWIN

If we have suffered or expect to suffer some wilful injury from a man, or if he is in any way offensive to us, we dislike him; and dislike easily rises into hatred. Such feelings, if experienced in a moderate degree, are not clearly expressed by any movement of the body or features, excepting perhaps by a certain gravity of behaviour, or by some ill-temper. Few individuals, however, can long reflect about a hated person, without feeling and exhibiting signs of indignation or rage. But if the offending person be quite insignificant, we experience merely disdain or contempt. If, on the other hand, he is all-powerful, then hatred passes into terror, as when a slave thinks about a cruel master, or a savage about a bloodthirsty malignant deity. Most of our emotions are so closely connected with their expression, that they hardly exist if the body remains passive—the nature of the expression depending in chief part on the nature of the actions which have been habitually performed under this particular state of mind. A man, for instance, may know that his life is in the extremest peril, and may strongly desire to save it; yet, as Louis XVI. said, when surrounded by a fierce mob, "Am I afraid? feel my pulse." So a man may intensely hate another, but until his bodily frame is affected, he cannot be said to be enraged.

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[1] Adapted from *The Expression of the Emotions in Man and Animals*, pp. 239-53. New York: D. Appleton & Co., 1896.

Rage.—Rage exhibits itself in the most diversified manner. The heart and circulation are always affected; the face reddens or becomes purple, with the veins on the forehead and neck distended. The reddening of the skin has been observed with the copper-coloured Indians of South America, and even, as it is said, on the white cicatrices left by old wounds on negroes. Monkeys also redden from passion. With one of my own infants, under four months old, I repeatedly observed that the first symptom of an approaching passion was the rushing of the blood into his bare scalp. On the other hand, the action of the heart is sometimes so much impeded by great rage, that the countenance becomes pallid or livid, and not a few men with heart-disease have dropped down dead under this powerful emotion.

The respiration is likewise affected; the chest heaves, and the dilated nostrils quiver. As Tennyson writes, "sharp breaths of anger puffed her fairy nostrils out." Hence we have such expressions as "breathing out vengence," and "fuming with anger."

The excited brain gives strength to the muscles, and at the same time energy to the will. The body is commonly held erect ready for instant action, but sometimes it is bent forward towards the offending person, with the limbs more or less rigid. The mouth is generally closed with firmness, showing fixed determination, and the teeth are clenched or ground together. Such gestures as the raising of the arms, with the fists clenched, as if to strike the offender, are common. Few men in a great passion, and telling some one to begone, can resist acting as if they intended to strike or push the man violently away. The desire, indeed, to strike often becomes so intolerably strong, that inanimate objects are struck or dashed to the ground; but the gestures frequently become altogether purposeless or frantic. Young children, when in violent rage roll on the ground on their backs or bellies, screaming, kicking, scratching, or biting everything within reach. So it is, as I hear from Mr. Scott, with Hindoo children; and, as we have seen with the young of the anthropomorphous apes.

But the muscular system is often affected in a wholly different way; for trembling is a frequent consequence of extreme rage. The paralysed lips then refuse to obey the will, "and the voice sticks in the throat"; or it is rendered loud, harsh, and discordant. If there be much and rapid speaking, the mouth froths. The hair sometimes bristles; but I shall return to this subject in another chapter, when I treat of the mingled emotions of rage and terror. There is in most cases a strongly-marked frown on the forehead; for this follows from the sense of anything displeasing or difficult, together with concentration of mind. But sometimes the brow, instead of being much contracted and lowered, remains smooth, with the glaring eyes kept widely open. The eyes are always bright, or may, as Homer expresses it, glisten with fire. They are some times bloodshot, and are said to protrude from their sockets—the result, no doubt, of the head being gorged with blood, as shown by the veins being distended.

Anger, Indignation.—These states of the mind differ from rage only in degree, and there is no marked distinction in their characteristic signs. Under moderate anger the action of the heart is a little increased, the colour heightened, and the eyes become bright. The respiration is likewise a little hurried, and as all the muscles serving for this function act in association, the wings of the nostrils are somewhat raised to allow of a free indraught of air; and this is a highly characteristic sign of indignation. The mouth is commonly compressed, and there is almost always a frown on the brow. Instead of the frantic gestures of extreme rage, an indignant man unconsciously throws himself into an attitude ready for attacking or striking his enemy, whom he will perhaps scan from head to foot in defiance. He carries his head erect, with his chest well expanded, and the feet planted firmly on the ground. He holds his arms in various positions, with one or both elbows squared, or with the arms rigidly suspended by his sides. Any one may see in a mirror, if he will vividly imagine that he has been insulted and demands an explanation in an angry tone of voice, that he suddenly and unconsciously throws himself into some such attitude.

Rage, anger, and indignation are exhibited in nearly the same manner throughout the world; and the following descriptions may be worth giving as evidence of this, and as illustrations of some of the foregoing remarks. There is, however, an exception with respect to clenching the fists, which seems confined chiefly to the men who fight with their fists. With the Australians only one of my informants has seen the fists clenched. All agree about the body being held erect and all, with two exceptions, state that the brows are heavily contracted. Some of them allude to the firmly-compressed mouth, the distended nostrils, and flashing eyes. According to the Rev. Mr. Taplin, rage, with the Australians, is expressed by the lips being protruded, the eyes being widely open; and in the case of the women by their dancing about and casting dust into the air. Another observer speaks of the native men, when enraged, throwing their arms wildly about.

Sneering, Defiance: Uncovering the canine tooth on one side.—The expression which I wish here to consider differs but little from that already described, when the lips are retracted and the grinning teeth exposed. The difference consists solely in the upper lip being retracted in such a manner that the canine tooth on one side of the face alone is shown; the face itself being generally a little upturned and half averted from the person causing offence. The other signs of rage are not necessarily present. This expression may occasionally be observed in a person who sneers at or defies another, though there may be no real anger; as when any one is playfully accused of some fault, and answers, "I scorn the imputation." The expression is not a common one, but I have seen it exhibited with perfect distinctness by a lady who was being quizzed by another person.

The uncovering of the canine tooth is the result of a double movement. The angle or corner of the mouth is drawn a little backwards, and at the same time a muscle which runs parallel to and near the nose draws up the outer part of the upper lip, and exposes the canine on this side of the face. The contraction of this muscle makes a distinct furrow on the cheek, and produces strong wrinkles under the eye, especially at its inner corner. The action is the same as that of a snarling dog; and a dog when pretending to fight often draws up the lip on one side alone, namely that facing his antagonist. Our word *sneer* is in fact the same as *snarl*, which was originally *snar*, the *l* "being merely an element implying continuance of action."

I suspect that we see a trace of this same expression in what is called a derisive or sardonic smile. The lips are then kept joined or almost joined, but one corner of the mouth is retracted on the side towards the derided person; and this drawing back of the corner is part of a true sneer. Although some persons smile more on one side of their face than on the other, it is not easy to understand why in cases of derision the smile, if a real one, should so commonly be confined to one side. I have also on these occasions noticed a slight twitching of the muscle which draws up the outer part of the upper lip; and this movement, if fully carried out, would have uncovered the canine, and would have produced a true sneer.

The expression here considered, whether that of a playful sneer or ferocious snarl, is one of the most curious which occurs in man. It reveals his animal descent; for no one, even if rolling on the ground in a deadly grapple with an enemy, and attempting to bite him, would try to use his canine teeth more than his other teeth. We may readily believe from our affinity to the anthropomorphous apes that our male semi-human progenitors possessed great canine teeth, and men are now occasionally born having them of unusually large size, with interspaces in the opposite jaw for their reception. We may further suspect, notwithstanding that we have no support from analogy, that our semi-human progenitors uncovered their canine teeth when prepared for battle, as we still do when feeling ferocious, or when merely sneering at or defying some one, without any intention of making a real attack with our teeth.

B[1]

BY G. STANLEY HALL

(1) Anger in most of its forms is the most dynamogenic of all the emotions. In paroxysms of rage with abandon we stop at nothing short of death and even mutilation of the corpse. The Malay running amuck, Orlando Furioso, the epic of the wrath of Achilles, hell-fire, which is an expression of divine wrath, are some illustrations of its power. Savages work themselves into frenzied rage in order to fight their enemies. In many descriptions of its brutal aspects, which I have collected, children and older human brutes spit, hiss, yell, snarl, bite noses and ears, scratch, gouge out eyes, pull hair, mutilate sex organs, with a violence that sometimes takes on epileptic features and which in a number of recorded cases causes sudden death at its acme, from the strain it imposes upon the system. Its cause is always some form of thwarting wish or will or of reduction of self-feeling, as anger is the acme of self-assertion. The German criminalist, Friedrich, says that probably every man might be caused to commit murder if provocation were sufficient, and that those of us who have never committed this crime owe it to circumstances and not to superior power of inhibition. Of course it may be associated with sex but probably no human experience is *per se* more diametrically opposite to sex.

Some temperaments seem to crave, if not need, outbreaks of it at certain intervals, like a certain well-poised lady, so sweet-tempered that everybody imposed on her, till one day at the age of twenty-three she had her first ebullition of temper and went about to her college mates telling them plainly what she thought of them. She went home rested and happy, full of the peace that passeth understanding. Otto

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[1] Taken from "The Freudian Methods Applied to Anger," *American Journal of Psychology*, XXVI (1915), 439–43.

Heinze, and by implication Pfister, think nations that have too long or too assiduously cultivated peace must inevitably, sooner or later, relapse to the barbarisms of war to vent their instincts for combat, and Crile thinks anger most sthenic, while Cannon says it is the emotion into which most others tend to pass.

It has, of course, been a mighty agent in evolution, for those who can summate all their energies in attack have survived. But few if any impulsions of man, certainly not sex, have suffered more intense, prolonged or manifold repressions. Courts and law have taken vengeance into their hands or tried to, and not only a large proportion of assaults, but other crimes, are still due to explosions of temper, and it may be a factor in nearly every court case. Society frowns on it, and Lord Chesterfield says the one sure and unfailing mark of a gentleman is that he never shows temper. Its manifestations are severely tabooed in home and school. Religion teaches us not to let the sun go down upon our wrath and even to turn the other cheek, so that we go through life chronically afraid that we shall break out, let ourselves go, or get thoroughly mad, so that the moment we begin to feel a rising tide of indignation or resentment (in the nomenclature of which our language is so very rich, Chamberlain having collected scores of English expressions of it), the censorship begins to check it. In many cases in our returns repression is so potent from long practice, that the sweetest smile, the kindest remarks or even deeds are used either to veil it to others, or to evict it from our own consciousness, or else as a self-inflicted penance for feeling it, while in some tender consciences its checked but persistent vestiges may become centers of morbid complexes and in yet other cases it borrows and proliferates more or less unconsciously, and finds secret and circuitous ways of indulgence which only psychoanalysis or a moral or religious confessional could trace.

(2) Anger has many modes of *Verschiebung*, both instinctive and cultivated. One case in our returns carries a bit of wood in his vest pocket and bites it when he begins to feel the aura of temper. Girls often play the piano loudly, and some think best of all. One plays a particular piece to divert anger, viz., the "Devil's Sonata." A man goes down cellar and saws wood, which he keeps for such occasions. A boy pounds a resonant eavespout. One throws a heavy stone against a white rock. Many go off by themselves and indulge in the luxury of expressions they want none to hear. Others take out their tantrum on the dog or cat or perhaps a younger child, or imprecate some absent enemy, while others curse. A few wound themselves, and so on, till

it almost seems, in view of this long list of vicariates, as if almost any attack, psychic or physical, might thus be intensified, and almost anything or person be made the object of passion. Be it remembered, too, that not a few look, do, think, feel their best under this impulsion.

(3) Besides these modes of *Abreagierung* there are countless forms of sublimation. In anger a boy says: I will avenge myself on the bully who whipped me and whom I cannot or will not whip, by besting him in his studies, class-work, composition, or learn skilful stunts that he cannot do, dress, or behave better, use better language, keep better company, and thus find my triumph and revenge. A man rejected or scorned by a woman sometimes makes a great man of himself, with the motivation more or less developed to make her sorry or humiliated. Anger may prompt a man to go in to win his enemy's girl. A taunt or an insult sometimes spurs the victim of it to towering ambition to show the world and especially the abuser better, and to be able to despise him in return, and there are those who have been thus stung to attempt greatness and who find the sweetest joy of success in the feeling that by attaining it they compensate for indignities they suffered in youth.

In fact, when we analyze ambition and the horror of *Minderwertigkeit* that goes with it, we shall doubtless find this factor is never entirely absent, while if we were to apply the same pertinacity and subtlety that Jung in his "*Wandlungen*" has brought to bear in working over the treacherous material of mythology, we might prove with no less verisimilitude than he has shown the primacy of the libido that in the beginning was anger, and that not Anaxagoras' love or the strife of Heraclitus was the *fons et origo* of all things, that the *Ichtrieb* is basal, and that the fondest and most comprehensive of all motives is that to excel others, not merely to survive, but to win a larger place in the sun, and that there is some connection between the Darwinian psychogenesis and Max Stirner and Nietzsche, which Adler has best evaluated.

(4) Anger has also its dreams and reveries. When wronged the imagination riots in the fancied humiliation and even tortures of an enemy. An object of hate may be put through almost every conceivable series of degradation, ridicule, exposure and disgrace. He is seen by others for what our hate deems him to be. All disguises are stripped off. Children sometimes fancy a hated object of anger flogged until he is raw, abandoned by all his friends, an outcast, homeless, alone, in the dark, starving, exposed to wild animals, and far more often more prosaic fancies conceive him as whipped by a parent or stronger friend, or by the victim himself later. Very clever strate-

gies are thought out in detail by which the weaker gets even with or vanquishes the stronger, and one who suffers a rankling sense of injustice can hardly help day-dreaming of some form of come-uppance for his foe, although it takes years to do it. In these reveries the injurer in the end almost always gives up and sues for mercy at the feet of his quondam victim. So weird and dramatic are these scenes often that to some minds we must call anger and hate the chief springs of the imagination. A pubescent girl who was deeply offended went off by herself and held an imaginary funeral of her enemy, hearing in fancy the disparaging remarks of the bystanders, and when it was all over and the reaction came, she made up with the object of her passion by being unusually sweet to her and even become solicitous about her health as fearing that her revery might come true. We all too remember Tolstoi's reminiscences when, having been flogged by his tutor, he slunk off to the attic, weeping and broken-hearted, and finally after a long brooding resolved to run away and become a soldier, and this he did in fancy, becoming corporal, lieutenant, captain, colonel. Finally came a great battle where he led a desperate charge that was crowned with victory, and when all was over and he stood tottering, leaning on his sword, bloody and with many a wound, and the great Czar of all the Russias approached, saluted him as saviour of his fatherland and told him to ask whatever he wanted and it was his, he replied magnanimously that he had only done his duty and wanted no reward. All he asked was that his tutor might be brought up and his head cut off. Then the scene changed to other situations, each very different, florid with details, but motivated by ending in the discomfiture of the tutor. In the ebb or ambivalent reaction of this passion he and the tutor got on better.

EXERCISE

1. Write an account of fear, joy, or sorrow showing its modes of expression and some of its varieties.

8. EXPERIMENTAL STUDY OF THE EMOTIONAL LIFE OF INFANTS

A[1]

BY JOHN BROADUS WATSON AND ROSALIE RAYNER WATSON

The experimental study of the emotions in adults is in a backward state in psychology. For one reason, emotions seem too evanescent and too complex for study. They run all the way in complexity from the simple blush of the boy or girl to the violent states we see in love and rage in which the individual is totally unfitted to carry out his ordinary activities. Early in our study of the emotional life of the infant we came to the conclusion that in them the emotional patterns are really quite simple and that the later complexity we see in the adult is brought about by training and environmental influence. But this training has been of an accidental character and under the control neither of the person in whom the emotion was built up nor of his parents and other associates. It seemed worth while to test out this hypothesis experimentally because it is important to bring the emotional life under some kind of scientific and practical control and to do this we must study how the early environment of the child forces emotional states upon him. Such a study it was hoped might result in a practical procedure by the use of which the child's life might be so shaped that undesirable emotions might not be implanted. On the other hand, granting that they had been implanted through carelessness or ignorance of parents and associates, we hoped to find methods by means of which they could be got rid of.

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[1] Adapted from "Studies in Infant Psychology," *Scientific Monthly*, XIII (1921), 505–14.

Our earliest observation showed that from birth three fundamental inherited emotional patterns could be observed. Without assuming that our observations are complete we feel reasonably sure that *fear*, *rage* and *love*[1] are original and fundamental. Our method of observing these emotions is a purely behavioristic one, that is, we make no effort to read into the mind of the child those things which psychologists have attempted to do for so long. We bring the child into the laboratory and stimulate it with those objects which we know will produce emotion in many adults and in nearly all children who have had the ordinary home bringing up. We then note the reaction that takes place. In other words, in any bit of behavior which can be observed there is always a stimulus or object present which calls out a reaction. The psychologist, then, must search for the objects which will call out emotions and then observe the reactions to each so that new forms of emotional expression may be found. We will apply this simple procedure to the infants brought up in the sheltered environment of the hospital where contact with the outside world has been kept at a minimum.

Fear.—What are the stimuli (objects or situations) which will bring out fear responses in infants? Our observation shows that the stimuli to fear are quite constant and quite simple. If the infant is held over a pillow and allowed to drop suddenly, the fear response appears. It can be brought out generally by a sudden shake or push or by suddenly pulling the blanket upon which it is lying. We might group all of these and say that *sudden removal of support* is an adequate stimulus to fear. The other most far reaching and important stimulus is that of a *loud sound;* for example, the striking of a long steel bar with a hammer is one of the most effective means of calling out this response. These are the common stimuli which are present almost daily in the life of every infant. The reaction or response to such stimuli is a sudden catching of the breath, clutching randomly with the hands, the sudden closing of the eyes, and the puckering of the lips followed in some cases by crying. In older children these reactions appear and in addition there is crawling away, running away and in some cases hiding the face. We have found no other stimuli which will call forth fear in the very young infant. It has been often stated that children are afraid of the dark, or animals, of furry objects in general. We shall show later that this is not the case.

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[1] By "love" Watson does not mean what Shand means by that term. "Love" for Watson is probably "joy" for Shand.—EDITORS.

Rage.—In a similar way we have studied the question as to the original objects and situations which will produce the response of rage. Our observations show conclusively that the *hampering of the infant's movements* is the one stimulus which apart from all training brings out the movements we should characterize as rage. If the head is held lightly between the hands, if the arms are held closely to the sides or if the legs are held tightly together the response appears. The body stiffens and if the arms are free slashing movements of the hands and arms result. If the legs are free the feet and legs are drawn up and down, the breath is held until the child's face is flushed. There is crying at first, then the mouth is opened to the fullest extent and the breath is held until the face appears blue. These states can be brought on without the pressure in any case being severe enough to produce the slightest injury to the child. The experiments are discontinued the moment the slightest blueness appears in the skin. Almost any child can be thrown into such a state and the reactions will continue until the irritating situation is relieved and sometimes for a considerable period thereafter. We have had this state brought out when the arms are held upward by a cord to which is attached a lead ball not exceeding an ounce in weight. The constant hampering of the arms produced by even this slight weight is sufficient to bring out the response. When the child is lying on its back it can occasionally be brought out by pressing on each side of the head with cotton wool. In many cases this state can be observed quite easily when the mother or nurse dresses the child especially in winter clothing.

Love.—The stimulus to love apparently is the stroking of the skin, tickling, gentle rocking, patting and turning the child across the attendant's knee on its stomach. The response in an infant depends upon its state. If it is crying the crying will cease and a smile may appear. In slightly older children there is a gurgling and cooing and in still older children the extension of the arms which we shall class as the forerunner of the embrace of adults. It is thus seen that we use the term "love" in a much broader sense than it is popularly used. The responses we intend to mark off here are those popularly called "affectionate," "good natured," "kindly," etc.

Whether these are all the emotional patterns that are strictly hereditary and not due to training we are not sure, and whether there are other stimuli which will call out these responses we must also leave in doubt, but if our observations are in any way complete it would seem that the emotional reactions are quite simple in the infant and the stimuli which call them out quite few in number.

How can we square these observations with those which show the enormous complexity in the emotional life of the adult? We know that hundreds of children are afraid of the dark, we know that many women are afraid of snakes, mice and insects, and that emotions are attached to many ordinary objects of almost daily use. Fears become attached to persons and to places and to general situations, such as the woods, the water, etc. In the same way the number of objects and situations which can call out rage and love become enormously increased. Rage and love at first are not produced by the mere sight of an object. We know that later on in life the mere sight of persons may call out both of these primitive emotions. How do such "attachments" grow up? How can objects which at first do not call out emotions come later to call them out and thus enormously increase the richness as well as the dangers of our emotional life?

Until recently no experimental work had been done which would show such emotional attachments in the making. We were rather loath to conduct such experiments, but the need of this kind of study was so great that we finally decided to undertake the building up of certain fears in the infant and then later to study practical methods for removing them. We chose as our first subject Albert B., an infant weighing twenty-one pounds at eleven months of age. We chose him particularly because of his stolid and phlegmatic disposition.

Before turning to the experiments by means of which we built up fears in this infant it is necessary to give a brief description of a method which has recently been developed in psychology, that of the "conditioning of reflexes." If a subject sits with the palm of his hand upon a metal plate and his middle finger upon a metal bar and an electrical current is sent through the circuit thus completed by the hand, the finger will fly upward from the metal bar the moment the electric shock is given. This painful stimulus is thus the native or fundamental stimulus which calls out the defensive reflex of the finger. The sight of an apple or the sound of a bell will naturally not produce this upward jerk of the finger. On the other hand, if the bell is sounded or the colored object is shown the moment the electric current is completed through the hand, and this routine is repeated several times, the situation becomes wholly different. The finger begins to jerk up reflexly now and then when the bell is rung or the colored object shown even if the electrical current is not sent through the hand. After a longer or shorter period of training the colored object will cause the jump of the finger just as inevitably as does the current. This we call a conditioned motor response and we have shown that these conditioned responses persist for long periods of time, in some cases possibly throughout the life of the individual. There is no "reasoning" or "association of ideas" involved, because we can produce conditioned reflexes in very low forms of animals. The same thing occurs in our glands. If one attaches a small apparatus to the parotid gland—one of the salivary glands in the cheek—in such a way that the saliva flows out drop by drop, it can be shown that the direct stimulus of the gland is *actual contact* with some edible or drinkable substance, for example, weak hydrochloric acid, vinegar, etc. The moment such an acid touches the tongue the gland begins to flow profusely. Ordinarily the sight of objects does not produce an increased flow of the glands, but if combined stimulations are given, the object being shown at the same time the acid is given, the sight of the object finally will produce an increased flow of the gland. This is of course what happens every time food or drink is brought to the mouth. Thus the youngster's mouth has every reason to "water" when a stick of candy is held in front of him or our own when we are hungry and a toothsome morsel is held before our eyes. It is probable that all of our glands, even the so-called ductless ones such as the thyroid or the adrenals, become conditioned by means of such environmental factors throughout our life.

We began to question, with such results as the above in front of us, whether or not entire emotional reactions such as are seen in fear might be conditioned in this simple way. If so we have an adequate way for accounting for the enormous increase in the complexity of adult emotional life as contrasted with its simpler manifestations in infants. To start the experiment it became necessary to use some simple native or fundamental stimulus which *would* produce fear (corresponding to the electrical shock). We have already pointed out that loud sounds are the most potent of all such stimuli. We determined to take Albert and attempt to condition fear to a white rat by showing him the rat and as soon as he reached for it and touched it to strike a heavy steel bar behind him. We first showed by repeated tests that Albert feared nothing under the sun except loud sounds (and removal of support). Everything coming within twelve inches of him was reached for and manipulated. This was true of animals, persons and things. His reaction, however, to the sound of the steel bar was characteristic and what we had been led to believe is true of most if not all infants. When it was suddenly sounded there was a sudden intake of the breath and an upward fling of the arms. On the second stimulation the lips began to pucker and tremble, on the third he broke into a crying fit, turned to one side and began to crawl away as rapidly as possible with head averted.

The result of this observation showing that the loud sound would produce an expression of extreme fear gave us hope that we might be able to use this stimulus for *bringing about a conditioned emotional response* just as the electric shock combined with the sight of the colored object brought about in the end the conditioned response of the finger just referred to. Our laboratory notes showing the progress of this test are most convincing.

Eleven months, 3 days old. (1) White rat suddenly taken from the basket and presented to Albert. He began to reach for rat with left hand. Just as his hand touched the animal the bar was struck immediately behind his head. The infant jumped violently and fell forward, burying his face in the mattress. He did not cry, however.

(2) Just as his right hand touched the rat the bar was again struck. Again the infant jumped violently, fell forward and began to whimper.

In order not to disturb the child too seriously no further tests were given for one week.

Eleven months, ten days old. (1) Rat presented suddenly without sound. There was steady fixation but no tendency at first to reach for it. The rat was then placed nearer, whereupon tentative reaching movements began with the right hand. When the rat nosed the infant's left hand the hand was immediately withdrawn. He started to reach for the head of the animal with the forefinger of his left hand but withdrew it suddenly before contact. It is thus seen that the two joint stimulations given last week were not without effect. He was tested with his blocks immediately afterwards to see if they shared in the process of conditioning. He began immediately to pick them up, dropping them and pounding them, etc. In the remainder of the tests the blocks were given frequently to quiet him and to test his general emotional state. They were always removed from sight when the process of conditioning was under way.

(2) Combined stimulation with rat and sound. Started, then fell over immediately to right side. No crying.

(3) Combined stimulation. Fell to right side and rested on hands with head turned from rat. No crying.

(4) Combined stimulation. Same reaction.

(5) Rat suddenly presented *alone.* Puckered face, whimpered and withdrew body sharply to left.

(6) Combined stimulation. Fell over immediately to right side and began to whimper.

(7) Combined stimulation. Started violently and cried, but did not fall over.

(8) Rat alone. *The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before he reached the edge of the table.*

This was as convincing a case of a completely conditioned fear response as could have been theoretically pictured. It is not unlikely had the sound been of greater intensity and the child more delicately organized that one or two combined stimulations might have been sufficient to condition the emotion. We thus see how easily such conditioned fears may grow up in the home. A child that has gone to bed for years without a light with no fears may, through the loud slamming of doors or through a sudden loud clap of thunder, become conditioned to darkness. We can easily explain how it is that a sudden flash of lightning finds you all set and tense, often times with the hands over the ears, before the clap of thunder, which is the true stimulus to such action, appears. We can thus see further how it is that the sight of a nurse that constrains the movements of the youngster or dresses it badly may cause the infant to go into a rage, or how the momentary glimpse of a maiden's bonnet may produce the emotional reactions of love in her swain.

The experimental question arose as to whether Albert would be afraid henceforth only of rats, or whether the fear would be *transferred* to other animals and possibly to other objects. To answer this question

Albert was brought back into the laboratory five days later and tested. Our laboratory notes again show the results most convincingly.

Eleven months, fifteen days old.

(1) Tested first with blocks. He reached readily for them, playing with them as usual. This shows that there has been no general *transfer* to the room, table, blocks, etc.

(2) Rat alone. Whimpered immediately, withdrew right hand and turned head and trunk away.

(3) Blocks again offered. Played readily with them, smiling and gurgling.

(4) Rat alone. Leaned over to the left side as far away from the rat as possible, then fell over, getting up on all fours and scurrying away as rapidly as possible.

(5) Blocks again offered. Reached immediately for them, smiling and laughing as before.

The above preliminary test shows that the conditioned response to the rat had carried over completely for the five days in which no tests were given. The question as to whether or not there is a *transfer* was next taken up.

(6) *Rabbit* alone. A rabbit was suddenly placed on the mattress in front of him. The reaction was pronounced. Negative responses began at once. He leaned as far away from the animal as possible, whimpered, then burst into tears. When the rabbit was placed in contact with him he buried his face in the mattress, then got up on all fours and crawled away, crying as he went. This was a most convincing test.

(7) The blocks were next given him, after an interval. He played with them as before. It was observed by four people that he played far more energetically with them than ever before. The blocks were raised high over his head and slammed down with a great deal of force.

(8) *Dog* alone. The dog did not produce as violent a reaction as the rabbit. The moment fixation of the eyes occurred the child shrank back and as the animal came nearer he attempted to get on all fours but did not cry at first. As soon as the dog passed out of his range of vision he became quiet. The dog was then made to approach the infant's head (he was lying down at the moment). Albert straightened up immediately, fell over to the opposite side and turned his head away. He then began to cry.

(9) Blocks were again presented. He began immediately to play with them.

(10) *Fur coat* (seal). Withdrew immediately to the left side and began to fret. Coat put close to him on the left side, he turned immediately, began to cry and tried to crawl away on all fours.

(11) *Cotton wool.* The wool was presented in a paper package. At the ends the cotton was not covered by the paper. It was placed first on his feet. He kicked it away but did not touch it with his hands. When his hand was laid on the wool he immediately withdrew it but did not show the shock that the animals or fur coat produced in him. He then began to play with the paper, avoiding contact with the wool itself. He finally, under the impulse of the manipulative instinct, lost some of his negativism to the wool.

(12) Just in play W. put his head down to see if Albert would play with his hair. Albert was completely negative. The two other observers did the same thing. He began immediately to play with their hair. A Santa Claus mask was then brought and presented to Albert. He was again pronouncedly negative, although on all previous occasions he had played with it.

We see that the conditioned fear to the rat, which was experimentally set up, transferred to many other objects. The transfer was immediate and without any additional experience in connection with these other objects. In these transferred emotional reactions we thus would find a reason for the widespread change in the personality of children and possibly even of adults once even a single strongly conditioned emotional reaction has been set up to any object or situation. It accounts for the many unreasoning fears and for a good deal of the sensitiveness of individuals to objects for which no adequate ground for such behavior can be offered in the past history of that individual. The importance of such a factor in shaping the life of the child needs no further emphasis from us.

B[1]

BY MANDEL SHERMAN AND IRENE CASE SHERMAN

DIFFERENTIATION OF EMOTIONAL RESPONSES BY OBSERVERS

Most people believe that they are able to differentiate between the various emotions of infants. But when large groups of observers are shown motion pictures of the behavior of normal infants in response to various stimuli, they do not agree in naming the emotions shown. A group of graduate students in psychology saw only the reactions of infants to four types of stimuli—namely, hunger, sudden dropping through a distance of from two to three feet towards a table, restraint of the head and face, and pricking with a needle on the face—the stimuli producing these reactions having been deleted from the film.

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[1] Adapted from the manuscript of *The Process of Human Behavior* to be published during 1929 by W. W. Norton and Co., New York.

They had been instructed to observe carefully the various reactions of the infants, such as arm, leg and body movements, facial expression, and the duration of crying. Nevertheless they named nine different emotions for the four responses. For the hunger reaction, 13 of the 32 observers named anger, 7 named hunger, 7 fear, and so on. For the response to dropping, which presumably produces fear, 15 judgments of anger were given, and only 5 of fear. For the response to pricking with a needle, only 3 judgments of pain were given, 9 naming fear and 9 anger. Although a fairly large percentage of the observers named anger for the reaction following restraint, an almost equal percentage also named anger for the reaction following dropping.

Another group of students who were shown motion pictures of a number of emotional reactions of infants and were told specifically that they would see only four different types of responses, namely, hunger due to a deferred feeding period, fear aroused by sudden dropping, anger resulting from light restraint of the head, and pain due to pricking with a needle, had no better success in naming the emotions shown than the observers who were not told how many and which emotions they would see. Only 10 percent of these observers named the hunger response correctly, 49 percent calling it pain, 25 percent anger and 15 percent fear. For the response to pricking with a needle, the most frequent estimate was fear; anger was considered to typify this reaction just as often as pain. Although for the response to dropping, fear was named more frequently than any other emotion, this estimate was made by 30 percent of the observers only, 27 percent (statistically a negligible difference) calling it anger. The response to restraint was detected more "successfully" than any of the others, 31 percent naming it correctly, although in all 69 percent failed to detect anger in it, 23 percent calling it pain.

Thus it is evident that observers have difficulty in recognizing the character of emotional reactions and in differentiating between them; and also that there is little correspondence between observers' judgments of the emotional responses of infants and the reactions generally expected to result from specific types of stimuli.

When, however, observers endeavor to guess the types of stimuli which have produced the responses they have attempted to name, the stimuli they list correspond closely with those which are generally expected to result in the particular emotional reactions. Most students of psychology, for example, learn that fear follows dropping or a loud noise, and accordingly when they label a particular emotional response as fear they assume that the stimulus which caused it was one of these. Although only four different stimuli were employed in a certain test, the observers, who were not told how many types of reactions they would see, listed fifteen different stimuli as probably used. When they named fear, 20 of 26 observers gave either dropping or a loud noise as the probable cause; for the pain reaction, they gave either pain, hunger, or intense light; for the hunger reaction, hunger, removal of food, sight of bottle, etc. These results show the influence of predetermined notions regarding the reactions which specific stimuli arouse. Of those who named anger as one of the emotional responses observed, only 17 gave restraint as the probable cause, 29 naming pain, which sows again the effect of definite attitudes concerning the causes of emotions.

THE INFLUENCE OF KNOWLEDGE OF THE STIMULUS UPON JUDGMENTS OF OBSERVERS

Even when observers of motion pictures of the emotional responses of infants also see the stimuli which produced the responses, they cannot agree in their estimates of the emotions, and give a wide variety of names for the reactions seen. Nevertheless their judgments in these cases correspond more closely with the emotions ordinarily expected to follow certain types of stimulation than when they do not see the stimuli. For example, the response to dropping they most frequently judged as fear; for restraint, the most common estimate was anger. Of the group who did not see the infant dropped, 16 percent named fear as the emotion shown, whereas of those who did, 63 percent named fear. For the reaction following restraint, 53 percent of the first group and 69 percent of the second named anger. For the response to pricking with a needle 12 percent of the first group and 32 percent of the second named pain. The hunger response, curiously enough, was actually detected less well when the observers were told that the child had not been fed than when they did not know the stimulating conditions, only 7 naming hunger while 15 named anger. Again, although 13 observers named pain for the reaction following pricking with a needle, an equal number named anger. Nevertheless it is evident that in the majority of cases knowledge of the stimulus influences the observer's ability to differentiate to emotional responses of infants.

When the motion pictures are arranged so that the emotional responses of infants are shown preceded by stimuli other than those which actually produced the reactions, a marked influence is noted upon the judgments of observers, which also goes to show that they are not based solely upon observed differences in the infants' responses, but are influenced by a knowledge of differences in the stimuli which have aroused the reactions. In one such test the observers, a group of medical students, were asked to note carefully the activity of the infants, such as movements of the arms, legs and body, movements of the head, the duration and apparent intensity of crying, and the manner of breathing, and to base their estimate of the emotions shown upon this behavior. Considerable lack of agreement was evidenced in differentiating and naming the responses. For the hunger reaction, which was shown following pricking with a needle, 60 percent of the observers named pain, but no one named hunger; for the reaction following dropping (presumably producing fear) which actually was shown following restraint, 43 percent named anger, the emotion one would expect to result from restraint; for the reaction following restraint, which was shown following dropping, 56 percent named fear, and only half that many named anger; and for the response following pricking with a needle, which was shown following a blank portion of film denoting a deferred feeding-period, 74 percent named hunger, but not one named pain. These observers were thus greatly influenced by the stimuli shown. Although they were specifically instructed to make their decisions upon the actual activity of the infants, their naming of the emotions was most frequently determined not by the actual reactions of the infant, but by the stimuli preceding the reactions.

Everyone is liable to error in judging the emotional expressions of infants. The reasons given by the observers (stimulus shown) for naming the reactions as they did are significant in accounting for their judgments. Many of them stated that they were able to name the various emotions because they were influenced either by seeing the stimuli given or by a knowledge of previous work in which it was found that certain stimuli give rise to certain definite emotional responses. Some said that they named the emotions according to the way *they* would feel if the same stimuli were given to them. In estimating the emotional behavior of infants, people tend to read into it their own attitudes towards the expected reaction, and each one makes his judgment on the assumption that since he himself reacts in a particular way to certain stimuli, infants must behave in a similar manner. Frequently we ascribe to the child reactions of which he is not at all capable. If we believe that the emotions are native characteristics with a predetermined pattern, we are very likely to attribute to the child emotional reactions which in reality may be merely attempts to adjust with the body as a whole to some stimulating condition. The infant even as old as six months does not show typical forms of behavior which can be characterized as definite emotions, but only generally aimless responses which can at most be called vaguely adaptive. It is only after the child begins to have knowledge of the social significance of his behavior that any of his responses can be named as definitely emotional. They have then become differentiated as a result of the formation of habitual methods of reaction which he utilizes in adjusting to specific situations arousing activity of the body as a whole.

Our judgments of the emotions of adults, although often based upon more definite behavior, also are influenced to a great extent by a knowledge of the environmental circumstances. The adult may show few evidences of emotional reactions, and yet if we know the situation which has produced his response we do not hesitate to label it as some particular emotion. The recent experimental studies made by Landis[1] indicated little correspondence between subjects' reports of the emotions they experienced in response to a wide variety of stimuli and their facial expressions as recorded by camera and motion pictures. When they tried voluntarily to register various emotions they gave the traditional expressions and not those actually obtained in emotional situations. Landis points out that observers viewing such pictures really make their judgments on the basis of their past experience with illustrated portraits and the like which have had labels attached to them naming the emotion, and not on the basis of similarities between the expressions and those that ordinarily occur.

JUDGMENTS BASED UPON ACTUAL BEHAVIOR OF INFANTS IN THE NURSERY

The motion-picture method of presenting the reactions of infants to observers is necessarily limited because certain aspects of the reactions are not visible, such as flushing or paling of the skin, changes in breathing, and the character of the cry. These sensory data should furnish additional clues in estimating emotional reactions if they occur in any consistent manner in the different emotions.

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[1] Landis, C. Studies of emotional reactions. I. Journal of experimental psychology, 1924, 7, 325–42. II, Journal of comparative psychology, 1924, 4, 447–509.

Medical students and student nurses were taken into the nursery in small groups and shown the actual behavior of infants who were stimulated in various ways to bring out supposedly definite emotions. They were told to observe the infants very carefully, as the reactions would be of comparatively short duration. Their attention was called particularly to movements of the arms, legs and body, the type and duration of the cry, the facial expression and any change in breathing. Immediately after the stimulus was applied, a screen which hid the infant from view was removed and the observers were allowed to watch its behavior. The screen was then replaced, another infant stimulated in a different way, and the observers again noted the reaction. All the infants observed were between 112 and 160 hours old.

Nine different emotions were named for the three reactions shown. The judgment most frequently given was colic; then in order of frequency came fear, anger, hunger, pain, and so on. The reaction following dropping of the infant was most frequently estimated as colic, four observers only naming fear. The reaction following restraint was estimated as anger, the emotion ordinarily expected to result, by only four, seventeen naming fear. Ten observers estimated pain as typifying the response to pricking with a needle, but an equal number named anger. There is thus no agreement between observers in estimating emotional reactions to stimuli which presumably arouse a given emotion, even when they see and hear the infants' responses, which shows that these reactions are not those generally expected.

EFFECT OF THE CRY UPON OBSERVERS

The character of the crying of an infant often is used as an aid in judging the emotion which it shows. It is ordinarily assumed that the cry differs in different emotions and that such differences may be detected easily. However, when variations are heard, they can be shown to be due to differences in the intensity, duration, and manner of application of the stimulus arousing the cry rather than to any intrinsic differences in the character of the cry in different emotions.

Many observers shown motion picture views of the emotional reactions of infants think they would be aided in judging the emotional character of the responses if they also could hear the crying of the child. Groups who watched the actual reactions in infants in the nursery, however, showed no better success in their estimates than those who only saw motion pictures of the responses. As these observers stated that they were watching the bodily movements of the infants, and did not direct their attention to the nature of the cry, groups of from two to five—graduate students in psychology, medical students, and nurses—were taken into the nursery and stationed in front of a screen behind which an infant was placed upon a table and stimulated. The screen was not withdrawn, but after the crying of the infant had subsided, the observers were asked to write the name of the emotion which it denoted, and their reasons for giving that particular name. In order that the judgments should be based on the quality of the cry, and not upon its duration, the infants were removed from the room after about two minutes, unless the cry subsided in a shorter time.

Considerable lack of agreement was shown by these observers. Ten different emotions were named for the response to four types of stimuli, the most frequent being colic, hunger, pain and anger. For the cry following a delayed feeding-period, only 6 observers named hunger, and 5 gave the same name to the reaction following a needle prick. Fear was named only once as characterizing the cry that followed dropping. For the cry following restraint of the head, presumably arousing anger, only 2 named anger, 4 naming fear and 5 pain. For the cry following pricking with a needle 5 named pain, but an equal number named hunger. There is thus little relation between judgments of the emotional character of an infant's crying and the emotion generally expected to result from a given type of stimulation.

Observers who heard the crying of the infant name 'colic' much more frequently than when they base their observation only upon motion-picture views. Not one judgment of 'colic' was made by the students of psychology who saw the motion pictures, and only 3 percent of the medical students named colic or gastric pain. When both groups made estimates of the cries of infants, however, 19 percent named 'colic.' This estimate was given more often than 'anger' or 'fear,' whereas in observing motion pictures, 'anger' and 'fear' were named more often than any other emotion. The crying of infants is thus very likely to suggest an organic disturbance.

When allowed to listen to the cry of an infant during its entire duration, after application of a stimulus, observers show a tendency to judge a cry which is prolonged over two or three minutes, and which subsides and increases rhythmically in intensity, as that of hunger. In general, this judgment proves correct. When crying is unusually long and intermittent, subsiding and recurring with sudden intensity, it usually is estimated as 'colic.' Again, a cry which is sharp, loud, and of short duration usually is judged as that of anger or cutaneous pain. The fact that, in general, observers name hunger or colic correctly when allowed to listen to an infant's crying for more than two minutes, but are unable to judge the character of the cry of a shorter period, indicate that these judgments result from the association of prolonged crying with some organic condition. Mothers, when unable to find any other cause for a child's prolonged crying, usually attribute it to hunger, pain or some other organic condition. This is also true of nurses.

Although most mothers believe that they can recognize the emotional character of the cry of their infants, they probably base their decisions upon a knowledge of the causative conditions producing the infant's reaction rather than upon the quality of the cry. The mother first looks at her child to see if he is hurt in any way, then she looks for pins which may be sticking him, looks at his clothing to see if it is too tight, and then perhaps observes the time of day to decide whether he is hungry. When the infant cries during or just preceding the usual feeding time she is likely to regard his reaction as due to hunger. In young infants the character of the cry during an emotional reaction is thus dependent not so much upon the type of emotional response as upon the character of the stimulating conditions arousing the reaction. In older infants and children, however, an additional factor is introduced which aids the parent in recognizing the emotional character of their cry. It becomes fairly definite in some situations, and the parent associates a given cry with and attributes it to a specific stimulus.

CONCLUSION

Most persons judge the emotional behavior of an individual in terms of the stimuli which have produced the reactions. They have learned the names of a number of emotions and have learned to evaluate various emotional responses in terms of the stimulating conditions which have aroused them. If the situation confronting an individual is estimated to be one which arouses an aggressive reaction, the resulting response is named 'anger,' but if it is considered dangerous to his welfare, the response will be called 'fear.' In this way the differentiation of emotions is based upon a knowledge of the character of the stimulating circumstances rather than upon differences in overt behavior. It is true that when differences in responses are marked, the reactions themselves also influence these judgments. If attempted escape by running away occurs in response to a stimulus, most persons ascribe the reaction to fear; if fighting results, the behavior is estimated as anger. Decisions concerning the adult's emotional reactions, however, are based primarily upon the stimulating circumstances, because his emotions are not manifested as overtly as those of children, *quantity*—i.e. intensity and duration—of the stimulus.

C[1]

BY MANDEL SHERMAN AND IRENE CASE SHERMAN

DIFFERENCES IN RESPONSES CAUSED BY QUANTITATIVE ASPECTS OF STIMULATION

Differences in the emotional responses of infants to various types of stimuli do occur, notwithstanding the fact that, as we have seen, observers generally cannot differentiate consistently between them. These differences, however, are due not to the quality, but to the *quantity*—i.e. intensity and duration—of the stimulus.

In infants about two weeks of age it is possible to obtain various kinds of adaptive reactions when a given type of stimulus is varied in intensity. Thus if restraint is applied lightly to the face for a short period it produces movements of the arms and head without crying, but if applied suddenly and with intensity the response is characterized by violent kicking, pushing movements of the hands, and crying. Although the character of the response following restraint of the face does not differ markedly from the reaction that results from pricking the face with a needle, if the intensity or duration of either of these stimuli is varied, the resulting reactions differ noticeably. The differences, however, if the stimuli are applied to the same part of the body, are manifest only in the intensity and duration of the response. A conclusion regarding a real difference in the responses to two types of stimuli, therefore, can be made only when these stimuli have the same quantitative value. Furthermore, certain stimuli which appear at first hand different in character may in reality produce the same type of response in the newborn infant. For example, it is possible that a loud, shrill sound actually stimulates pain nerve endings, just as pricking with a needle does, and that the resulting reaction may be due to this painful stimulation. If so, differences between the reactions to a harsh, loud sound and to pricking with a needle may arise as a result of differences in the duration or intensity of the two painful stimuli, rather than as a direct result of the quality of each stimulus.

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[1] Adapted from the manuscript of *The Process of Human Behavior* to be published during 1929 by W. W. Norton and Co., New York.

The quantitative aspect of a stimulus is indeed the most important factor influencing the character of the reaction which follows. Bodily movements, such as raising and lowering the arms, flexion and extension of the legs, and movements of the trunk and head usually are directly proportional in their rate and duration to the strength of the stimulating condition. Spasmodic breathing and holding of the breath, so often described as characteristic of certain emotions only, are also related to the intensity and duration of the stimulus. This is illustrated in the reaction to pricking with a needle. When this stimulus is applied lightly and is repeated but once or twice an infant usually only puckers its lips and perhaps cries for a few seconds, but when applied with some intensity and repeated quickly several times loud spasmodic crying occurs, with holding of the breath between the periods of crying.

EFFECT OF THE QUANTITATIVE ASPECT OF THE STIMULUS AS ILLUSTRATED BY VARIATIONS IN CHARACTER OF THE CRYING OF INFANTS

When a mildly painful stimulus is applied to a young infant, the cry is neither as intense nor as prolonged as when the same type of stimulus is given with greater intensity. The character and duration of the cry are also related to the bodily movements made by the child. When a stimulus produces a great amount of bodily activity, the cry is more intense and continues longer than when bodily activity is slight. Such activity, however, probably is a function of the intensity of the stimulus, and so is related only indirectly to the cry. In general, the more intense the stimulating conditions, the sharper is the ensuing cry. When a painful stimulus is applied with little intensity, the cry which follows is low-pitched and of short duration, but when applied with intensity, it begins suddenly, is of longer duration, and high-pitched in quality. The character of the cry is also related to its duration; within limits, the greater the duration of the cry the more intense it tends to become. The cry of hunger furnishes a good example of this relationship. The cry of a hungry infant observed within a period of thirty minutes following the usual feeding-time begins gradually, is intermittent, and increases slowly in intensity. The intervals of quiet become less frequent with the lapse of time, and the cry following them begins more suddenly and with greater intensity than during the first few minutes.

The duration of an infant's crying increases with the continuation of the stimulating conditions. For example, the length of the crying following restraint for ten seconds is invariably greater than that following restraint for three seconds, although the increase is not proportional to the increase in duration of the stimulus. The average duration of the cry of a number of infants following restraint for ten seconds was found to be 20.2 seconds, and for restraint for three seconds, 9.6 seconds.

The manner of application of a stimulus also influences the character of the ensuing cry. When needle pricks are applied gradually, the cry of the infant begins relatively slowly and increases quickly to its full intensity. When the pricks are applied suddenly and in quick succession, however, the cry begins after a brief latent period, and reaches its greatest intensity at the outset. The cry following sudden and very firm restraint of the face is more sudden, more intense and higher in pitch than that following gradual restraint. In the latter, there usually is a relatively long latent period, and the intensity of the ensuing cry increases gradually. If the restraint is continued the cry soon changes in character to the type of cry which follows almost immediately as a result of sudden and very firm restraint.

A comparison of the hunger cry of most infants with that of infants ill with colic also illustrates the influence of the suddenness and intensity of the stimulating conditions. The crying of normal infants observed just before feeding-time usually is rhythmical in character, dying down gradually, beginning again after a short interval, and gradually rising to its greatest intensity. In only a few infants is the hunger cry sudden or spasmodic. In infants with gastro-intestinal disturbance, on the other hand, the cry is sudden and spasmodic, begins with great intensity, subsides relatively quickly, and is accompanied by widespread spasmodic bodily activity. Following a quiet interval of varying duration, during which the infant may whimper, the cry is resumed in a similar manner. In hunger the contractions of the stomach wall begin gradually with no acute spasms. In colic, on the other hand, the intestinal contractions are quite marked and spasmodic in character. For this reason colic produces a more intense organic stimulus than hunger, and the onset of the stimulus is also more sudden. This sudden, intense character of the stimulus in colic results in sudden, intense and high-pitched crying.

Many conditions other than the qualitative character of the stimulus influence the type of an infant's cry, and make it difficult for an observer to estimate its emotional character. We have already seen that the time of day in relation to the feeding-period is a factor. The age of the infant is also a factor, although a variable one. The duration and intensity of the cry generally are not as great in infants less than twenty-four hours old as in older infants. Infants who are considered irritable and fidgety react with more intense and prolonged crying than infants considered quiet and good in the nursery. Infants who have a private nurse show greater reactivity than those who do not, for, as we have seen, the increased handling, which means an increased number of stimuli received, results in a lowering of the threshold of irritability.

EXERCISES

1. Enumerate some common fears and show how they may be developed from other specific fears.
2. Why do people believe that they can identify emotions accurately, when. as a matter of fact, they are unable to do so?

CHAPTER XIX

THE CONTROL OF ACTION

1. CONSCIOUSNESS AND MOVEMENT

A[1]

BY EDWARD BRADFORD TITCHENER

If we consider the facts of organic movement as they are presented in our own experience; if, following the rule of psychological enquiry, we set out from an examination of our own action and conduct; we find that the phenomena cannot be brought at once under the head of any single principle, but that they rather result from the joint operation of two different tendencies. On the one hand, we are continually enlarging our sphere of action; conduct grows more complex; new motives are formed, new adaptations made; there is a tendency towards more and more complicated or specific coordinations of movements. The realization of this tendency is always accompanied by consciousness, by the mental formations that are known, both in popular speech and in psychology, as choice, resolve, deliberation, judgment, doubt, etc. On the other hand, there is a tendency towards the simplication of movement; coordinations that at first involved cortical activity are presently, as a "habit" is formed, relegated to lower centers. And the realization of this tendency is accompanied by lapse or loss of consciousness. We learn to walk, to swim, to bicycle, to typewrite, to play a musical instrument, with conscious pains and effort. Later, if we practise enough, we do these things "automatically," unconsciously. We may typewrite correctly while our attention is wholly directed upon the meaning of our paragraph; we may play a musical composition correctly while we are engaged in an absorbing conversation. The original impulsive or selective or volitional action has become automatic. We can, of course, bring its terms back to consciousness; we can stop and "think" that we are typewriting or playing the piano or bicycling; but if we do this, the movements become hesitating and may be seriously deranged. If the natural tendency takes its course, we finally reach a form of movement which (except that we know its course of development) is not distinguishable from the physiological reflex.

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[1] Taken from "Were the Earliest Organic Movements Conscious or Unconscious? *Popular Science Monthly*, LX (1902), 465–68.

Here is a bit of positive and unmistakable evidence. It is possible, in the life history of the individual, for conscious movements to pass over into unconscious. Not only is it possible: it is a regular occurrence. From the biological point of view, it is eminently useful; the simplification of response to stimulus, its relegation to lower nervous centers leaves the organism free for further adaptations. Is there not some ground, then, for generalizing the facts, and saying that, probably, *all* unconscious movements have developed from conscious? This is what Wundt has done, in his statement that "the reflexes are voluntary actions that have become mechanical. Only, his terminology is at fault, for the antithesis of the voluntary is not the mechanical (all actions, biologically regarded, are mechanical), but the unconscious action; and the antithesis of the reflex is not the voluntary but the complex, coordinated action. So difficult is it, even when one's thought is scientifically clean, to avoid the language of "common sense."

I think that the reader who has recognized the weakness of the opposing theory will take great comfort in this piece of undisputed fact, and will be willing to generalize it farther than the logical canons warrant. To myself, brought up in the faith that mind developed somehow and appeared somewhere after the birth of life, and always unsuccessful in any attempts to reconcile this faith with reason, Wundt's counter-statement came as a real illumination. Nevertheless, as it stands, it is nothing more than an argument from analogy; we argue from the individual to the race. Is there no evidence from the race itself?

We find a little—as much, perhaps, as we have a right to expect. There is a class of movements, familiar to every one who has read Darwin's "Expression of the Emotions in Man and Animals," which are known in psychology as "expressive" movements. Such are the opening of mouth and eyes in surprise, the frown and clenched fist of anger, the play of the facial muscles in joy and sorrow. These movements belong to various psychological classes, volitional, selective impulsive, reflex. But there are among them certain reflexes—primary reflexes, not automatic actions or "secondary" reflexes of the kind just described—that can only be explained as the unconscious descendants of earlier impulsive actions. The face of proud contempt reflexly "curves a contumelious lip." What does the movement mean? Why, it lays bare the canine teeth; it is the human counterpart of the snarl of dog or wolf; it is the last reflex or unconscious remnant of a coordinated or impulsive action which, somewhere or other in our not remote ancestry, preceded the movements of actual attack. The deer bounds away when it hears the hounds, and we "jump" when we are startled; the sitting bird crouches on its nest when danger approaches, and we wince or shrink when we are frightened or censured. The connection is obvious; the activities are related; but the action which formerly was conscious has become, in us, a mere "automatism." Instances of this sort might easily be multiplied.[1] The facts are admitted, and their explanation accepted, by psychologists of all schools. But here is evidence of the derivation of unconscious from conscious movement, not in the life history of the individual, but in that of the race.

In both of the cases which we have discussed, consciousness has shown itself to be chronologically prior to unconsciousness. Are there any known cases to the contrary? Have we any instance of an action which, unconscious in the lower animals or early in our own lives, later becomes conscious? Have we any hint of a tendency in this direction? On the former count, as regards the animals, the appeal must lie to the "objective criterion" of mind, and therefore to biology as well as to psychology. I can only say that the psychological evidence is negative, and that I have not myself—speaking, however, as a layman in biology—come across any positive indications in biological literature. On the latter, as regards ourselves, I find no evidence either in psychological literature or in my own experience. *Omne consciens e conscienti* is the law of conduct known to the psychologist. It may be retorted that the negative evidence is worth very little, since, *e.g.*, we believe that life evolved from inorganic matter, and yet no one has seen the not-living pass over into the living. I reply that the evidence is at least negative, that is, is not positive; and that, although we have not built up living protoplasm from dead matter, we have at least gone a good way towards it.

There is another point. The automatic actions that take shape in the course of the individual life have upon them the marks of appropriateness, of "purposive" response to stimulus. They are relatively precise and clean-cut; they subserve some one end, or some set of interrelated ends. Appropriateness and precision are also, notoriously, characteristic of the physiological reflexes. They are similarly characteristic, we are told, of the tropisms and stereotyped reactions of the lowest forms of life, so that these are often spoken of as "reflexive." Is not this item of internal evidence worth something? Is it not probable that things which are so much alike have had a similar history? For it must be remembered that, however simple the organism which we are examining, it is still not a primitive organism; its history is, presumably, at least as long as the history of man. Not until we see the organism take shape from its inorganic constituents, and note the first reactions of the living mass, shall we have direct evidence of the nature of primitive movement, but by all analogy, that movement will not be precise and clean-cut, but vague and clumsy, indefinite and irregular. It is surely reasonable to suggest that the two tendencies which we find in ourselves, and which (on the testimony of expressive movements) are also operative in the race —the tendency towards new coordination and progressive adaptation, with consciousness, and towards specialized and stationary adaptation, without consciousness—were present from the very beginning, that the rudimentary organism might as circumstances dictated, follow either of two paths, the downward path to static adjustment, by reflexes, or the upward path to dynamic adjustment, by conscious and coordinated action; and that in following the first path, it forever lost the power of higher development, while, in following the second, it still retained the power of fixing stably the reactions whose modification was unnecessary. Paramecium would then have lost the faint flicker of mind with which its original ancestor was endowed, and, losing therewith the possibility of coordinated movement, would have remained paramecium. But a primitive organism of like endowment, living under different conditions, and retaining both mind and the correlated physical adaptability, would have become man.

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[1] It would be especially interesting to examine from this point of view the movements of the new-born infant. The position taken in the text is, I think, supported by, *e.g.*, the mimetic facial reflexes, and by the various atavistic reflexes (hanging from stick or finger, swimming movements, etc.) But a full consideration of all these movements would require a separate paper. On the other hand, the fact that in the higher animals the reflexes are imperfect at birth, and take a little time to "harden"—a fact which has been rightly emphasized in several recent studies of animal behavior—does not seem to touch the present argument one way or the other.

B[1]

BY IRVING KING

Impulses the basis for the development of consciousness.—The reflex and habitual activities of adult life are accompanied by little or no consciousness. We are undoubtedly conscious when we are performing habitual acts, but chiefly with reference to some other activity or with reference to the end in view, and not as to the habitual movements themselves. If we turn now to the child, we find no acquired habits, as with the adult, but instincts. Its reflexes are like the adult's but fewer in number. These two classes of movements are both the result of co-ordinations that the child brings into the world with him, and hence he has had no conscious part in their formation. Neither in their origin nor in their working can we assume that consciousness plays any necessary part, because, as has been pointed out, it does not *merely accompany* the processes of activity, but arises for the purpose of directing it and readjusting it. Reflex and instinctive acts do not have to be directed (and ordinarily not readjusted); hence we have no right to assume that these mechanical movements are any more conscious in children than in adults. If the child is conscious, it must be with reference to the other sort of activity, namely, the impulsive. *In these unco-ordinated movements, then, is the basis for the development of consciousness.* As mere unco-ordinated responses they are, of course, no more present in consciousness than are the reflex and instinctive movements, but they form *the raw material for adjustments.* They are something that can be molded, that lend themselves to adjustment in varying situations. We may take these from the start as the indices to the nature of the conscious life. As long as the only co-ordinations are hereditary, and all other movements are purely impulsive, we can think of the child's consciousness as being only of the most rudimentary sort. Co-ordinate with every adaptation of an impulse to an end, however, a more and more definite consciousness arises.

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[1] Taken from *The Psychology of Child Development*, pp. 73–77. Chicago: University of Chicago Press, 1903.

We have next to note *the process by which impulses become adapted* and consciousness defined. If the child, in throwing its arms about, chances to strike something, its movement is arrested. The checking of the movement must make the child more definitely conscious of it. If the checking of the impulsive movement results in doing something with the obstacle, the movement has made the first step toward organization; perhaps it is a block or spool on which the baby's hand has chanced to fall, and it is picked up instinctively and carried in an instinctive fashion to the mouth. But the purposeless impulse has here accidentally served an end, and if the child is afterward any more definitely conscious of this movement than at first, it is no longer as *mere* movement, but as movement-stopped-by-something. Perhaps it is assuming too much to think of this effect's being produced at first. We cannot doubt, however, that in the child's haphazard excursions many such accidents will occur, and that it is just such incidents that make the various movements stand out from one another in the child's consciousness. As soon as movement stands out, that is, as soon as the consciousness of it is interwoven with something that is *not* movement—or, we may say, as soon as consciousness is not of movement in general, but some particular kind of movement—we have the basis for indefinite advance. The child at first by no means recognizes a separate object; its consciousness is not that of movement plus object, *but of movement different in some way;* out of the vague, undefined consciousness a conscious-complex has arisen.

The first co-ordinations to arise are, of course, extremely simple, as ability to use the eyes together, and later to gaze at some object, such as a bright light, or to follow it with the eyes. But in every case we have at first accidental, impulsive movements, and we cannot doubt but that as the movement becomes co-ordinated, consciousness itself becomes more definite. In the formation of these simplest co-ordinations it is not easy to see how an intensification of consciousness is really involved, but the process is the same as in the more complex cases where there can be no question as to its being produced. We are, therefore, surely justified in regarding the first beginnings of the complex conscious life as consisting in the formation of these simple organized movements.

First conscious life an unspecialized one.—We have then, in the child, a consciousness of the kind above described—a consciousness in which the division of labor has not proceeded far enough to warrant our selecting one element in a reaction, *e.g.*, a feeling or an idea, and describing the reaction in terms of it. In this undifferentiated consciousness, as we have seen, true emotions are necessarily of the most rudimentary description, an emotion, like an idea, being a developed, complex product, not a primary datum. The various expressions of the child in the first few months, which have usually been interpreted as evidence of emotional states, as we have shown, need have no such significance. In a word, the infant starts with direct impulsive uncoordinated responses to all sorts of stimuli. Its conscious life increases in indefiniteness and in variety as the activity, which it mediates, presents increasing difficulties of adjustment to the ends that are to be realized.

EXERCISE

1. Make a critical comparison of the views of Titchener and King as expressed above.

2. THE REACTION EXPERIMENTS[1]

BY OSWALD KÜLPE

SIMPLE REACTIONS

A reaction is a movement made in response to a sense impression. If it follows directly upon the reception of the impression, we have a *simple* reaction; if some further conscious process is interpolated between sensation and motor innervation, a *compound* reaction. The simple reaction, therefore, is very similar to the physiological *reflex*, in which a movement of definite muscle groups results from the direct transmission of a sensory stimulation to motor centres, without the participation of consciousness. Indeed, no sharp line of distinction can be drawn between the reflex and the simple reaction. The reaction experiment consists in the measurement (by an electric clock or by graphic registration) of the duration of the whole chain of processes from the moment of stimulation to the execution of the movement. The experiment is useful in two ways. (*a*) The differences in the times obtained serve to express the quickness or slowness of the part-processes contained in the reaction, and indicate the direction and magnitude of the various influences to which it is subject. (*b*) And the frequent repetition of the same act enables us to analyse with some degree of certainty the various factors which compose the reaction itself. This analysis is of special importance in view of the high degree of complexity which actions ordinarily exhibit. The reaction is simply the exact type of all actions, as they are called in the psychology of every day life, which are initiated by an external stimulus. The reaction experiment, therefore, presents many points of interest aside from the question of its duration. It helps us to understand the nature and conditions of our practical relations to the external world. And it has contributed largely to our knowledge of the sensory conditions of sensation, of association, of the connection of conscious elements, etc. The wide range of its results has naturally rendered it a favourite of investigation in experimental psychology. But physiology and astronomy are also interested in the measurement of reaction times; physiology, because it supplies a method for the determination of the rate of propagation of a sensory nervous excitation; and astronomy, because the registration of observations of stellar transits consists simply in the execution of reactions.

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[1] Adapted from *Outlines of Psychology*, pp. 406–11. (Translated by Edward Bradford Titchener.) London: Swan Sonnenschein & Co., 1895.

The duration of a simple reaction is dependent upon *external* and *internal* conditions. (i) The most important external condition is the *quality* of the initiatory sense impression. Reaction to light takes longer than reaction to sound or pressure; reaction to taste is also comparatively slow, and reaction to smell and temperature slowest of all.[1] The *intensity* of the impressions is undoubtedly of importance: the stronger the stimulus, within certain limits, the shorter is the reaction time. (ii) The changes which are due to the influence of internal conditions are of greater psychological importance. Besides altering the duration of the whole act, they usually imply a qualitative modification of its contents. Especially important in this connection is the *preparation* of the subject for the reaction. If the stimulus is given unexpectedly, the reaction time is considerably lengthened, and in many cases an emotion is produced (the reactor is surprised or, in extreme instances, startled), which is directly inhibitory of the requisite motor innervation. Even when the expectation is adequately adjusted to the experiment, the results differ very widely with its direction and intensity. It is customary to distinguish two types of simple reaction; the *sensorial* or complete and the *muscular* (motor) or abbreviated forms. The reaction is sensorial, when expectation is directed on the sense impression, and no special preparation is made for the movement. It is muscular, when expectation is concentrated as exclusively as possible on the answering movement, and no particular preparation is made for the sense impression. The psychology of

TABLE XVI*

Observer	Optical Stimulus	Acoustic Stimulus	Stimulus of Touch
	Sec.	Sec.	Sec.
Hirsch	0.200	0.149	0.182 (hand)
Hankel	0.225	0.151	0.155
Donders	0.188	0.180	0.154 (neck)
Von Wittich	0.194	0.182	0.130 (forehead)
Wundt	0.175	0.128	0.188
Exner	0.1506	0.1360	0.1276 (hand)
Auerbach	0.191	0.122	0.146
Von Kries	0.193	0.120	0.117

* Ladd and Woodworth after Kries and Auerbach.

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[1] Table XVI gives an idea of the differences between reaction times to different kinds of stimuli as they have been obtained by a number of the earlier investigators.—Editors.

these forms of expectation differs very widely in actual experimentation; capacity of reproduction varies in different individuals, and the degree of preparation does not remain constant for the same subject Thus, if the reactor is unable to ideate a sense impression with sufficient vividness, he will give the prescribed direction to his expectation by the help of judgments of an appropriate kind, or of the organic sensations aroused by the strain in sense organ or organ of movement, or perhaps of visual ideas of the stimulus or of the movement to be made in response to it. These different forms of sensorial or muscular preparation still await accurate analysis. In all probability, certain differences in the determination of reaction times are largely due to differences in the form of expectation.

The objective result of this difference in preparation is that the sensorial reaction takes longer than the muscular. But the qualitative course of the two processes is also different. In the muscular reaction, the sense impression acts merely as a stimulus to the release of the movement, which is quick and spasmodic; in the sensorial reaction, there is not only a clear perception of the stimulus but also a conscious innervation of the movement. This difference accounts for certain characteristic reaction types, the *premature* and *erroneous* reactions, which not infrequently occur with muscular preparation. The premature reaction consists in the execution of the prescribed movement before the sensory stimulus has been given; the erroneous reaction in the execution of the required movement in answer to some other stimulus than that which is employed in the experiment. In either case, the subject is often ignorant that he has reacted wrongly.

It is not difficult to discover analogies between these forms of the simple reaction and certain activities or actions in everyday life. Everyone must have had experiences which recall the premature or erroneous reaction; and everyone knows the difference between two actions, one of which is continuously directed by the idea of its end, while the other is accomplished step by step, as it were, each stage in its execution requiring special preparation. When the series of factors involved in an action has become familiar by long practice, there can be no doubt of the advantage of a constant idea of its ultimate conclusion. The predominance of the one idea makes it quicker and more accurate, and effects a saving of energy as well as of time. The sensorial reactions, when they have been thoroughly practised, bear a very close resemblance to the *habitual* actions of ordinary life. The connection which has grown up between a sensation and a movement is brought about in the particular case without any special decision,—without any reflection at all. A vast number of our daily actions are performed in this way, except that the process is usually initiated by connections of sensations and concluded by combinations of several movements. The term "association" would seem to be as applicable to this process as to the interrelation of sensations; for the laws and conditions which obtain for the reproduction of movements by ideas are the same with those for the reproduction of sensations by sensations. Actions of this kind have also been named *ideomotor*.

THE ANALYSIS OF COMPOUND REACTIONS

Psychologists have been principally interested in the compound reactions, in which (according to the current hypothesis) the execution of the movement is delayed by definite mental acts performed at once on the reception of the sense impression, in accordance with a prescribed rule. Donders was the first to attempt a determination of the rapidity of judgment, choice and discrimination by a subtraction of the simple from the compound reaction time; and his example has been followed by many subsequent investigators. Now it is clear that the result is only valid if the interpolation of the mental act constitutes the sole change in the course of the reaction, *i.e.*, if preparation, sensory stimulation and movement are precisely identical in both the simple and the compound form. The investigation of compound reactions will, however, lose nothing of its importance, even if we find reason to mistrust these particular calculations of the duration of different mental activities. For the real value of the measurement of compound reactions consist (*a*) in the furtherance of an accurate analysis of the individual components by the frequent repetition of the same process, and (*b*) in the illustration of the influence of different conditions upon the course of the action. And these objects of inquiry are not touched at all by the possibility or impossibility of a separate statement of the duration of definite mental acts. The interpolated processes have been those of cognition, discrimination, choice, reproduction, and judgment.

EXERCISES

1. Why is the *sensorial* reaction called complete and the *muscular* abbreviated?
2. Do you think that an accurate measurement could be made of the duration of mere conscious processes apart from stimulation and movement? Why, or why not?

3. THE NATURE OF THE MENTAL STATES WHICH PRECEDE MOVEMENTS[1]

BY EDWARD L. THORNDIKE

The problem.—Psychologists have argued much about what kinds of mental states are the antecedents of movements in purposive action. The arguments concern chiefly (1) the so-called *feelings of innervation*, (2) the feeling of *decision*, of *consent*, of *"let this act be,"* the *fiat*, and (3) the *memory images of the feelings produced by the movement.*

By feelings of innervation are meant feelings directly due to the passage of the nervous impulse to efferent neurones and through them to the muscles. It is very doubtful whether any feelings are so caused. They certainly are not essential to the execution of a purposely made movement. The feeling of decision has already been described. Though of frequent occurrence, notably in action after deliberation, it cannot be regarded as a *sine qua non* of purposive action, as defined here; for of the thousand intentional acts of a day, only a small number are preceded by it. The *memory images of the feelings produced by the movement* are of two sorts, *Resident* and *Remote.* By *resident* feelings are meant the feelings of tension, movement and the like *of the moving part,* due to the movement itself. By *remote* feelings are meant the feelings of any sort secondarily caused by the movement, *e.g.*, the sound due to the movements of saying a word, the pressure due to grasping a stick, the sight of the clinching and clinched fist due to the same movements.

Any variety of mental state may precede a voluntary act.—Nearly all writers on psychology seem sure that some special sort of feelings must be present in purposive action. Some think the feeling of decision must always be there; some think that feelings of innervation must be there; nearly all think that at least memory images of the feelings produced by the movement must be there. Only recently has it been argued that after all there is no justification for the assumption that any peculiar sort of feeling is a necessary element of purposive action; that really *any mental state whatever may be the antecedent of an intentional act.* Yet this seems easily demonstrable. For instance, I just now completed the purposive action of writing, "Yet this seems easily demonstrable." The act was certain finger and arm movements and certain eye movements involved in guiding them. But my antecedent state of mind contained no images whatever of feelings in my fingers, arms or eyes, nor even of the sight of the words. It was simply the judgment, "Yet this seems easily demonstrable," felt with the auditory images of the words. A few hours ago I signed a lease, and I can confidently affirm that the thought antecedent to the act contained no images of any sensations in any way connected with the act of writing my name, but only the auditory images, "He came to my terms after all." Professor James, who maintains that "whether or no there be anything else in mind at the moment when we consciously will a certain act, a mental conception made up of these sensations (of the movement's results) . . . . must be there," gives illustrations which prove precisely that the antecedent to a movement need never have been its *result*. "We say, 'I must go downstairs,' and ere we know it we have risen, walked, and turned the handle of a door." "Hallo! I must lie here no longer," is the antecedent of getting out of bed.

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[1] Adapted from *Elements of Psychology* (2d ed.), pp. 281–84. New York: A. G. Seiler, 1907.

The feelings produced by a movement rarely cause it.—In fact, the doctrine that the image of some one of the previous *results* or *effects* of a movement is its necessary antecedent in purposive action makes the perversest of mistakes. The antecedent is some one of its previous *preliminaries* or *causes*. Occasionally what was first a result or effect of a movement may later be thought of as a preliminary, and so become its antecedent in still later connections, but in general what has *led* to a movement, not what has *come after it*, will lead to it on future occasions. It is not the image of a mouth full of liquid, but the sight of the bottle, that makes the baby reach out its hands. It is not the feeling of a brush on one's head, but the thought "I must comb my hair," that assists our toilet. It is not the thought of feeling warm, but of feeling cold, that commonly makes one build a fire. It is the thought of a bill as due, not as having been paid, which makes us draw a check. We do not move our eyes so as to focus them on an object because we see it clearly, but because we don't. We do not eat because we feel full in imagination, but because we feel empty in reality.

EXERCISE

1. Consider the foregoing discussion in the light of the differences between the *sensorial* and the *muscular* forms of reaction (see pp. 626 f.).

4. THE DEVELOPMENT OF CONTROL[1]

BY J. H. BAIR

One of the aims of this experiment[2] was to determine whether the definite idea of a movement is sufficient to enable one to reproduce it at will. Our results justify us in saying *No.* As has already been explained in the preceding discussion a definite kinaesthetic idea of the movement of the undeveloped ear muscle was given by the artificial contraction of that muscle. The idea of the movement thus produced was a memory image of the sensation which was the concomitant of the movement, plus also a visual memory image of the movement. Yet the contraction could not be made voluntarily, not even after it was repeated a sufficient number of times thoroughly to impress the sensation and definitely to fix the association between the muscular sensation and the visual impression of it. With all this preparation the subject failed to reproduce the movement voluntarily and there was no sense of innervation. To refer again to the introspection, the subjects could feel no output of nervous energy, or, to quote the words of one of the subjects, "It seemed like trying to do something when you have no idea how it is done. It seemed like willing to have the door open or some other thing to happen which is beyond your control."

All that was done by this preliminary work, *i.e.*, producing the contraction artificially, was to give a vague idea of the direction of the act. And in the great effort to reach the ear a great deal of motor energy was discharged into muscles lying approximate. The brow was raised, the teeth clinched, and this proximity was perceived and a more strenuous effort was made to get closer, until finally the ear was budged. As soon as the ear was reached the sensation was cognized and it became the fixation point of the attention. In other words, the attention was narrowed down from the general sensation of the innervation of the adjacent muscles to the sensation of the specific movement sought for. The first time the ear movement was effected by voluntary effort the sensation was but faintly recognized on account of its feeble nature. Here the subjects who had had the benefit of the artificial contraction had a positive advantage over those who had not, in that they had already a definite memory image of the movement, and as soon as it was reproduced, it would be recognized, whereas it could not be recognized, except in a very vague way, in the second case. It is a well-known fact that any particular sensation or element of a complex can be recognized or singled out more easily in the complex if it has been presented previously by itself, as *e.g.*, in the case of a compound clang, any note in it can easily be singled out by the attention if previously given separately. And this is as true of the other senses as of the auditory.

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[1] Adapted from "Development of Voluntary Control," *Psychological Review*, VIII (1901), 499–502.

[2] Subjects who could not at the outset of the experiment voluntarily move their ears were taught not only to move them, but to control the movements. The muscle involved was in certain cases stimulated at first by an electric current which automatically brought about the required movement.—EDITORS.

Although the sensation attending the ear movement was identified as soon as the least response was effected, yet at the same time the subject was perfectly aware that only a small part of the total sensation came from the ear; and in repeating the innervation he would try to have a greater part of this complex sensation experienced from the ear. In thus trying harder to move the ear farther the brow would also be raised higher, the jaws set more tightly, etc., so that relatively the sensation experienced from the ear may not have been greater than before, but absolutely it was very much greater. The process continued until the ear muscle could be contracted to its maximum. The ear was definitely located with reference to the other muscles which were innervated with it. An association was made between the sensation from the ear and the sensations coming from the whole group.

As soon as the sensation arising from the movement of the ear was associated with the concomitant sensations of muscles close to it, over which there was already definite voluntary control, there was a basis for learning the voluntary control of the ear. To put this into a general statement would be to say that in order to acquire voluntary control of a new muscle it must be associated with the movement of some muscle we already know. This principle, if it can be shown to be true, which, it seems to me, our facts would make indisputable, is entirely consistent with a well-known pedagogical principle of association on the intellectual side, namely, that we can only get hold of a new thing in terms of what is already known. If we cannot associate it in any way with our past experience it can never have any significance for us.

We now come to the second part of the process. We have gotten a hold on the ear by association with muscles known. The next thing to do, now, since this association is made and the ear can be made to respond to an effort of the will, is to break up this association and move the ear independently. In the accomplishment of this the attention is the all-important thing. This sensation which satisfies the effort, *i.e.*, the one attending the contraction of the proper muscle, becomes the thing upon which the attention is focused. The associated muscles are gradually relaxed. They respond less with each trial until finally only the ear responds. The rapidity with which this is accomplished is entirely proportional to the concentration of the attention. The attention directed to one activity tends to inhibit the other activities which may be in progress at the time. This is a conclusion which we could not help but draw from our facts and introspection. It was the experience of all that the more completely the attention could be concentrated on the movement to be made the greater was the attending success. When all the attention was put upon the movement while the brow was forgotten the movement could be made without any of the concomitant brow movement, whereas when part of the attention was directed on inhibiting the brow movement while the other part was directed to the ear movement both ear and brow responded together.

EXERCISE

1. Suppose that you wanted to be able to move the third finger of your left hand independently of your other fingers. How would you proceed to train yourself?

5. PURPOSE[1]

BY RALPH BARTON PERRY

Let us start with that state of a man in which he is said to be prepared for future action, or to have his plans made so far as concerns what he is himself to do. A good example is afforded by the chess player who has a series of moves ready in advance, or the foresighted housewife who has made up her mind what to cook for each successive meal for the coming week. Future responses are at least partially organized, and are held in reserve in the order of their appropriate stimuli. As each in turn is called into play the next in order moves into its place, just as in baseball the "batter-up" moves towards the batter's box, selects his bat and makes a few preliminary swings. While the serial order of prepared responses is not always as clear as this, something of the kind is a constant feature of human conduct. Immediately behind what I am doing now there is what I am going to do next, and behind that, successive lines of reserves which advance toward the front as my action unfolds. A similar situation must be supposed to exist when a response is only partially executed. A football player about to catch and run back a punt has the whole action outlined in advance. At the same time that he is watching the ball in its course through the air he is ready with neuro-muscular coordinations of the arms and legs to grasp the ball, ward off tacklers and run down the field. At any given instant in the course of this action some part of it is being carried out, while other parts are carried as far forward as is possible without interference with that part which is being carried out. So far are these preparations carried that the organism is at the time incapable of doing anything else, and will if "over-anxious" carry the preparation too far, as when the running-response crowds the catching-response and causes the player to fumble the ball.[1]

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[1] Taken from "A Behavioristic View of Purpose," *Journal of Philosophy*, XVIII (1921), 95–97.

We may say, then, that most human action instead of being born *de novo* at the moment of performance merely passes over from an implicit or partial state to an explicit or complete state. The organism is, loaded and aimed, in short, before it is fired. Or the organism is ordinarily in a state of being committed in advance of performance. These reserve responses must be supposed to possess an unqualified physiological existence, even though they are not in action and even though they should never be called into action. It is unnecessary to dwell upon the various forms which these may assume. They may be so related that the action of each provides the stimulus for the action of the next, in which case they were in some sense parts of one plan: or they may be correlated with successive stimuli externally and independently supplied, as when one is prepared for a sequence of probable contingencies.

Now let us suppose such a reserve or partial response to be in the advanced stages of preparation and then to be checked through the non-appearance of the complementary stimulus or through some impediment. Either one of two things will happen. If there are other prepared responses for which the appropriate stimuli are present, the organism may go over to another course of action. If, however, the first course of action possesses a temporary monopoly of the energies of the organism, responses will occur which have the character of being auxiliary. These may assume the form of "random" activities, habits or inherited reflexes, for which suitable stimuli are presented. This will continue until some one of the random activities provides the complementary stimulus or removes the impediment and so permits the original response to complete itself. But in proportion as an organism is "experienced" in the matter such auxiliary activities are not random. Certain of the present stimuli have acquired "meaning." The immediate response which they excite is again, as in the case of the original response, the first of a series of acts. Successive ulterior acts are made ready to take their turn. But in some cases these tentative reserves will coincide and in some cases they will conflict with the suspended response. Where the former is the case the tentative act will be performed and where the latter occurs the act will be abandoned after having been "considered."

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[1] Or the anticipatory set may have so much momentum that it is impossible to readjust quickly to a change in the situation. A good example is afforded by the case of the subject who being prepared to lift a heavy weight is given a light one instead, with the result that it is flung high above the head with a wholly disproportionate expenditure of energy. (Quoted from Müller by James, *Principles*, 1890, II, p. 502, note.)

We have now obtained a first approximation to a view of interested or purposive action. An act is performed because its prepared sequel or implicit phase coincides with the incomplete part of some course of action that is at the time dominating the organism. Under the tension created by a suspended response an organism performs one or more acts which *promise* the act or acts in which the response is carried out. Let us call the suspended response which for the time commands the energies of the organism, the *determining tendency;* and let us use the expression *auxiliary responses* for the acts which occur under the influence of such a tendency when its completion is delayed.

6. THE FEELING OF EFFORT[1]

BY TH. A. RIBOT

Every one knows by experience that voluntary attention is always accompanied by a feeling of effort, which bears a direct proportion to the duration of the state and the difficulty of maintaining it. Whence does this feeling of effort come, and what does it mean?

Effort from attention is a particular instance of effort in general, the most common and best known manifestation of which is the effort that accompanies muscular work. Three opinions have been propounded to account for the origin of this feeling:

First, that it is of central origin—anterior to movement, or at least simultaneous therewith; that it passes from within to without; that it is centrifugal—efferent; the feeling of energy being displayed; not resulting, as in sensation proper, from an external influence transmitted by the centripetal nerves (Bain).

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[1] Taken from *The Psychology of Attention* (6th ed.), pp. 59–61. (Revised) Chicago: Open Court Publishing Co., 1911.

Secondly, that it is of peripheral origin—posterior to the movements produced; that it passes from without to within; that it is afferent; the feeling of energy that *has been* displayed; that, like every other sensation, it is transmitted through centripetal nerves from the periphery of the body to the brain (Charlton, Bastian, Ferrier, W. James, etc.).

And, thirdly, that it is both central and peripheral: a feeling of force exerted, or feeling of innervation, and also a feeling of movement accomplished; that first it is centrifugal, and then centripetal (Wundt). This composite theory also seems to be that accepted by J. Müller, one of the first who studied this question.

The second thesis, which is the most recent, appears the most tenable one. It has been very carefully expounded by Mr. W. James in his monograph "*The Feeling of Effort*" (1880), in which the thesis of the feeling of energy developed prior to movement has been criticized with great acumen. The author, in discussing the facts successively involved, has pointed out, that if in cases of paralysis of a part of the body or of an eye, although the member remains motionless, the patients have the feeling of energy developed (which seems to justify the thesis of a feeling of a central innervation anterior to movement), it is because a movement is really produced in the other part of the body, in the corresponding limb, or in the eye which has not been paralyzed. He concludes thence, that this feeling is a complex afferent state resulting from the contraction of muscles, the extension of the tendons, the ligaments, and the skin, from compressed articulations, from an immovable chest, closed glottis, knit eyebrows, set jaws, etc.; in a word, that, like all sensations, it is of peripheral origin. Even for those who can not accept this thesis as definitive, it is certain that it explains the facts far more satisfactorily and far more in conformity to the general laws of physiology than the hypothesis which connects this feeling with the motor nervous discharge—the motor apparatus being insensible in the centripetal direction.

EXERCISE

1. Which of the foregoing theories would the average man be likely to hold? Why?

7. INHIBITION[1]

BY IRVING KING

The conception of inhibition.—Now, by an inhibition of an act we mean the checking or stopping of it, not by any mysterious force or fiat, but by another act. A voluntary act may be inhibited by another voluntary act through the arising in consciousness of an image that lies back of the first act. A reflex may be inhibited by a violent sensory stimulus. Thus Preyer tells us that he caused the auditory reflexes in new-born guinea pigs to be inhibited by pinching the ears sharply. He also mentions a sixteen-day-old child that was screaming violently, but became "quiet in an instant when it was laid face downward on a pillow." He mentions the quieting effect on very young babies of singing and playing on the piano. According to Preyer, however, "we have not here to do with inhibitions of reflexes in the strict sense of the term, but with the supplanting of a feeling of discomfort, along with its motor consequences or a reflex activity, by means of a new impression."

But this is exactly what we have held that inhibition really is—the supplanting of one sort of activity by another. Preyer evidently thinks of inhibition as a fiat of some kind that comes in and simply annihilates an activity, leaving nothing in its place. From our point of view such a thing is inconceivable. Just as in the physical world a moving body can be stopped only by another body sufficiently large, at rest or in motion, with some at least of its elements pointing in a direction opposite to that of the motion checked, so, whatever be the cause of an act, whether psychical or physical, that act can cease only when the energy that stimulates it is exhausted, or when the energy is diverted into other channels.

Activity inhibited by activity.—That this is the most satisfactory way of viewing the facts of inhibition we shall see if we review those instanced by Preyer. The case of the screaming child quieted by being laid face downward is clearly, as he points out, a case of the supplanting of one attitude by another. The nervous energy used in crying is diverted and scattered by the change of position. The hushing effect of music is undoubtedly due to the scattering of the impulse to fret or cry through the rhythmical excitation of the entire body by the external harmony. Any excitation like crying—in fact, any emotion or any special activity—involves the centralizing of nervous energy in certain portions of the body. If this energy can be collected in some other portion, or if it can be scattered rhythmically in every direction, the activity is inhibited by another definite act, or inhibited by being dissipated into a diffused activity of the entire organism.

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[1] Adapted from *The Psychology of Child Development*, pp. 110–13; 114–15.

This is the true functional point of view. Every activity is functionally related to the situation in which it occurs. The only way for an activity to cease short of sheer exhaustion is for the situation to change so that a new act appears as a function of the changed conditions. To hold that an act could be stopped by a pure fiat would involve us in the position that there is no organic relation between our activity and the situations in which we exist. If this point of view is true, inhibition is by no means an indication of an organized volitional attitude, as Preyer and Tracy hold. Whenever one act checks and takes the place of another, we have true inhibition, whether it be in the infant two or three weeks old or in the adult. Such a substitution of acts becomes evidence of a developed consciousness; that is, one containing a volitional attitude when there is a consciousness of the results of the inhibited act, or when new elements in a situation are realized and sought for to the exclusion of the previous line of action. In other words, a counteracting activity may be set up either to stop the previous activity or because it is itself more desirable. In either case we have simply one act crowded out by another.

The point of this discussion has been to show that we have here no extraneous elements, no new factor in inhibition, but only a name for the fact that one act may supplant another.

EXERCISE

1. Compare King's description of inhibition with the statement that "one habit can be broken only if another is formed."

8. VOLUNTARY ACTION[1]

BY G. F. STOUT

Voluntary action is to be sharply discriminated from impulsive action, and deliberation from conflict of impulsive tendencies. The difference is, that in impulse action follows the isolated conative tendency; whereas in voluntary decision special conations and their ends are first considered in their relation to the total system of tendencies included in the conception of the Self. When two disconnected impulses simultaneously prompt to incompatible courses of action, if the conception of Self does not come into play, one interferes with the other in a quasi-mechanical way. There is merely a trial of brute strength between them. Instances are sometimes found in young children and animals. The characteristic expression of their mental state is a sort of oscillation between two modes of action, each of which is begun in turn and then gives place to the other. "When a young child suddenly comes face to face with a strange dog, the impulse towards . . . . and the impulse away from . . . . are realised in quick succession. The child goes up to the dog, runs back to its father, approaches the dog again, and so on." Professor Titchener tells us that "in face of the two impulses, (1) to shut a door on the right hand and (2) to seat himself at his typewriter-table on the left," he actually began "a right-hand movement towards the door and then all at once" slued round "to the typewriter, without having closed it." All of us can no doubt recall similar experiences.

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[1] Adapted from *A Manual of Psychology* (3d ed.), pp. 706–31. London: University Tutorial Press.

Deliberation in no way resembles this alternate jerking in opposite directions, as if pulled by a string, and the decision which follows it is not a mere triumph in strength of one isolated impulse over another. Voluntary action does not follow either of the conflicting tendencies, as such; it follows our preference of the one to the other. It is the conception of the Self as agent which makes the difference. The alternative is not "this?" or "that?" but "shall *I* do this?" or "shall *I* do that?" Each line of action with its results is considered not in isolation but as part of the ideally constructed whole for which the word "I" stands. The impulse of the present moment belongs to the Self of the present moment; but this is only a transient phase of the total Self. If the impulse is realised the completed action will take its place as a component part of the life-history of the individual. He may live to regret it. In his present mood, with bottle and glass before him, he may desire to get drunk; but sobriety may have been the habit and principle of a lifetime. If he yields to temptation, the remembrance of the act will stand out in painful conflict with his normal tendencies. He will be unable to think of it without a pang. This incompatibility between the normal Self and the present impulse, if vividly enough realised at the moment of temptation, will restrain him from drinking. If it is not sufficient, further developments of the conception of Self may be more efficacious. He may think of himself as church warden or elder; he may think of the ideal aspirations of his better moments; he may call to mind the thought of himself as reflected in other minds,—the dead friend who expected so much from him, and who would be so shocked at his lapse,—the talk of the general public conceived as pitying, contemptuous, or malicious. He may even consider how he would like to look back to such an episode on his death-bed. Obviously, this detailed development of what is included in the man's conception of himself as a whole might go on interminably. As a matter of fact, it is possible that it would not be needed at all. He might simply say, "What! *I* do such a thing? How could the thought ever have occurred to *me?*" In this case the mere concept of the Self in its vague totality without detailed development would be sufficient to produce a decision. The thought of *getting drunk* attracts the man; but the thought of *his* getting drunk repels, so as to give rise to instant rejection of the suggested course of action.

Deliberation.—Very often, however, the thought of the Self does not at once give rise to a decision, positive or negative, but only to arrest of action, so as to give time for deliberation. It may be that the way in which this or that line of conduct, if realised, would affect the Self as a whole, past, present, future, and ideal, can only be brought before consciousness with sufficient fulness to determine action by a more or less prolonged train of thought. When this is so, the concept of the Self as a whole will not directly tend to reinforce or suppress a desire; it will rather tend to postponement of action, until the concept of Self and of the action and its consequences are developed in such detail in relation to each other that a decision becomes possible. In this way arises Deliberation. The alternatives before the mind in deliberating may be simply doing a thing or leaving it undone; or they may include two or more definite and incompatible lines of action. In principle, there is no essential difference between the two cases. When two or more definite lines of action are considered, each of them has to be brought into relation with the general concept of Self, and from this point of view they have to be compared with each other.

The general point of view in deliberation may be described as follows. A certain line of action being suggested as possible, I contemplate myself as I shall be if I put it in execution, so as to make it part of my actual life-history, and on the other hand I contemplate myself as I shall be if I leave it undone. I follow out this representation of a hypothetical Self in more or less detail until that turning-point in the process which is called Voluntary Decision emerges.

Deliberation may be regarded as a state of unstable equilibrium. The mind oscillates between alternatives. First one conative tendency becomes relatively dominant, and then another. The play of motives passes through all kinds of vicissitudes, as the alternative courses of action and their consequences are more fully apprehended in relation to the Self. As the process advances, equilibrium tends to be restored. New developments of conative tendency cease to take place; deliberation comes to a standstill because it has done its work. In this relatively stationary condition, it may be that one of the alternatives, with the motives for it, has a decided and persistent predominance in consciousness, so that the mind no longer tends to revert to the others. At this point the mind is made up, and the result is formulated in the judgment, "I will do this rather than that."

Involuntary Action. Fixed ideas.—In the strictest sense an involuntary action is one which takes place in opposition to a voluntary decision. Thus if I am determined to make a certain stroke at billiards, and if in the moment of action the muscular apparatus fails me, so as to give rise to an unintended jerky movement, my action is strictly involuntary. But cases like this do not interest us here. What we are concerned with is the defeat of the will, not by an accidental circumstance interfering with its execution, but by an antagonistic impulse. We have an example of this in the unsuccessful effort to restrain a reflex movement over which we have normally sufficient control. Suppose a party of soldiers to be climbing a crag in the dark so as to surprise a castle. Noiselessness is a condition of success. A sneeze or a cough probably means defeat and loss of life. Now it is possible to a large extent to restrain the actions of sneezing and coughing; but if the irritation of the mucous membrane is sufficiently intense and persistent, temporary repression only makes the ultimate outburst more violent. One of the soldiers may be determined not to sneeze, although the impulse is so strong as to give him great uneasiness. The tendency to sneeze is a conation; to restrain it is painful, and to indulge it would be a relief. None the less, if the impulse prove irresistible the sneeze is involuntary.

In this instance the involuntary act follows on organic sensation and not on an idea. It does not take place because the ideal representation of the act of sneezing has become predominant, but merely because of the intense irritation of the mucous membrane.

There is, however, a wide class of instances in which the will is defeated by the obtrusive intensity of an ideal representation. In spite of the mental assertion that we are not going to perform a certain action, the idea of that action, owing to other conditions, acquires and maintains a dominance in consciousness which ultimately leads to its realisation.

This may happen even when the ideally represented object is not desired, and even when the only feeling towards it is that of intense aversion. A man standing on an eminence, such as the top of a cathedral tower, and looking down into the vast depth beneath him, thinks of what it would be like to throw himself down. Owing to the fascinating interest of the thought the idea of the action and its consequences obtrudes itself upon him with intense vividness, and he feels himself impelled to carry it into execution. He may have a very distinct and clear volition to the contrary; he may utterly refuse to identify the idea of the action with the idea of Self. He mentally asserts, I shall not, or, I will not; and as a rule this voluntary decision triumphs over the "fixed idea" as it is called. But it still remains true that the fixed idea derives its vivacity from conditions independent of the will; and it is always possible that the impulse to realise it may acquire sufficient strength to overcome a contrary volition. Some people actually do throw themselves down precipices in this way.

This result however is not common under normal conditions. It is in pathological cases that the fixed idea becomes really formidable. This is partly due to imperfect powers of deliberation. The conative tendencies which would have restrained the act lie in abeyance; the concept of the Ego in its unity and totality can only be very inadequately developed in relation to the act contemplated. But there are instances in which this explanation does not apply. In such instances it is not the absence of inhibiting tendencies, but the positive strength of the impulsive idea which leads to action. Ribot gives a case of a man who was possessed by the idea of killing his mother. " 'To you,' said he, 'I owe everything; I love you with all my soul; yet for some time past an incessant idea drives me to kill you.' " Tormented by this temptation, he leaves his home, and becomes a soldier. "Still a secret impulse stimulated him without cessation to desert in order to come home and kill his mother." In time, the thought of killing his mother gives place to that of killing his sister-in-law. Someone tells him that his sister-in-law is dead, and he accordingly returns home. "But as he arrives he sees his sister-in-law living. He gives a cry, and the terrible impulse seizes him again as a prey. That very evening he makes his brother tie him fast. 'Take a solid rope, bind me like a wolf in the barn, and go and tell Dr. Calmeil. . . . .' From him he got admission to an insane asylum. The evening before his entrance he wrote to the director of the establishment: 'Sir, I am to become an inmate of your house. I shall behave there as if I were in the regiment. You will think me cured. At moments perhaps I shall pretend to be so. Never believe me. Never let me out on any pretext; the only use I shall make of my liberty will be to commit a crime which I abhor.'"

This is a case in which the fixed idea was not executed; but it easily might have taken effect, and many similar cases could be adduced in which it actually did so. What it is important to note is the conflict between the Self as a whole arranged on the side of the volition, and the isolated impulse to action which derives its strength merely from the fixation of an idea by pathological conditions. In these cases the conation which resists the will arises primarily from the fixation of the idea in consciousness. The fixation of the idea itself does not arise from any desire for its object. But under normal as opposed to pathological conditions, the commonest cases of involuntary action are those in which an idea becomes fixed through intense appetite or craving arising from organic conditions.

Self-control. All the cases of involuntary action which we have discussed in the last section are cases of deficiency of self-control. Self-control is control proceeding from the Self as a whole and determining the Self as a whole. The degree in which it exists depends upon the degree in which this or that special tendency can be brought into relation with the concept of the Self and the system of conative tendencies which it includes. Failure in self-control may arise from one or both of two conditions. On the one hand, the overpowering intensity of a relatively isolated impulse may prevent the due evolution of the concept of Self even when this is fully formed and organised. On the other hand, the defect may lie in the degree of development which self-consciousness has attained, or in organic conditions, mostly of a pathological kind, which disorganise the Self, and prevent the full development of its normal contents. To quote Dr. Clouston: "The driver may be so weak that he cannot control well-broken horses, or the horses may be so hard-mouthed that no driver can pull them up. Both conditions may arise from purely cerebral disorder. . . . . An imbecile or dement, seeing something glittering, appropriates it to himself. . . . . The motives that would lead other persons not to do such acts do not operate in such persons. I have known a man steal who said he had no intense longing for the article he appropriated at all, at least consciously, but his will was in abeyance, and he could not resist the ordinary desire of possession common to all human nature." On this Professor James remarks: "It is not only those technically classed imbeciles and dements who exhibit this promptitude of impulse and tardiness of inhibition. Ask half the common drunkards you know why it is that they fall so often a prey to temptation, and they will say that most of the time they cannot tell. It is a sort of vertigo with them. Their nervous centres have become a sluice-way pathologially unlocked by every passing conception of a bottle and a glass. They do not thirst for the beverage; the taste of it may even appear repugnant; and they perfectly foresee the morrow's remorse. But when they think of the liquor or see it, they find themselves preparing to drink, and do not stop themselves; and more than this they cannot say." We have a good example of the inverse case in which the concept of Self is fully organised and easily developed, but finds itself impotent in the face of an abnormally intense impulse, in the case of the man who was possessed by the fixed idea of murdering his mother.

The process of ideal construction through which the concept of Self grows, is gradual, and reaches different degrees of perfection in different persons. The more highly systematised and organised it becomes, the more effective it is. Self-control is greatest in the man whose life is dominated by ideals and general principles of conduct; but this involves a development of conceptual consciousness which is absent in children and savages. We accordingly find that children and savages are to a great extent creatures of impluse; they have comparatively little power of deliberation, so that action tends to follow the conative tendency which is excited and supported by the circumstances of the moment. Remoter considerations are comparatively inoperative. The Self which determines action is predominantly the present Self, not the total Self as ideally represented. Thus the savage wastefully exhausts his present store in riotous indulgence, and is improvident of the future. He cannot be brought to work in a regular and persistent manner. He may be industrious enough for a time in order to gain a little money, or some other object which he happens to covet at the moment; but so soon as his immediate end is attained, he thinks no longer of working, but only of enjoying his gains. He is scarcely capable of pursuing a distant aim, which requires persistent and repeated activity continued for a long time without obvious result. Ends which are at least in part immediately attainable seem to be the only ends which effectively determine his action. For this reason he does not appreciate the value of time. The end he is pursuing at the moment has for him an absolute rather than a relative importance. He does not regard it merely as part of the great business of life which must be subordinated to the whole. He does not feel the necessity of completing the transaction on which he is interested in time to proceed to other matters. Hence he often sorely tries the patience of the civilised European by spending altogether disproportionate time and energy on relatively trivial bargains, etc. Such mottoes as "time is money" do not appeal to the savage mind. The same holds of young children, as we all know. The bird in the hand is to them worth a thousand in the bush.

EXERCISES

1. Why are we less likely later to be ashamed of deliberate action than of immediate or impulsive action?
2. In what sense can one act against his will?

9. FIVE TYPES OF DECISION[1]

BY WILLIAM JAMES

Turning now to the form of the decision itself, we may distinguish four chief types. The first may be called *the reasonable type.* It is that of those cases in which the arguments for and against a given course seem gradually and almost insensibly to settle themselves in the mind and to end by leaving a clear balance in favor of one alternative, which alternative we then adopt without effort or constraint. Until this rational balancing of the books is consummated we have a calm feeling that the evidence is not yet all in, and this keeps action in suspense. But some day we wake with the sense that we see the thing rightly, that no new light will be thrown on the subject by farther delay, and that the matter had better be settled *now.* In this easy transition from doubt to assurance we seem to ourselves almost passive; the "reasons" which decide us appearing to flow in from the nature of things, and to owe nothing to our will. We have, however, a perfect sense of being *free,* in that we are devoid of any feeling of coercion. The conclusive reason for the decision in these cases usually is the discovery that we can refer the case to a *class* upon which we are accustomed to act unhesitatingly in a certain stereotyped way. It may be said in general that a great part of every deliberation consists in the turning over of all the possible modes of *conceiving* the doing or not doing of the act in point. The moment we hit upon a conception which lets us apply some principle of action which is a fixed and stable part of our Ego, our state of doubt is at an end. Persons of authority, who have to make many decisions in the day, carry with them a set of heads of classification, each bearing its motor consequence, and under these they seek as far as possible to range each new emergency as it occurs. It is where the emergency belongs to a species without precedent, to which consequently no cut-and-dried maxim will apply, that we feel most at a loss, and are distressed at the indeterminateness of our task. As soon, however, as we see our way to a familiar classification, we are at ease again. *In action as in reasoning, then, the great thing is the quest of the right conception.* The concrete dilemmas do not come to us with labels gummed upon their backs. We may name them by many names. The wise man is he who succeeds in finding the name which suits the needs of the particular occasion best. A "reasonable" character is one who has a store of stable and worthy ends, and who does not decide about an action till he has calmly ascertained whether it be ministerial or detrimental to any one of these.

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[1] Taken from *The Principles of Psychology,* II, 531–35. New York: Henry Holt & Co., 1890.

In the next two types of decision, the final fiat occurs before the evidence is all "in." It often happens that no paramount and authoritative reason for either course will come. Either seems a case of a Good, and there is no umpire as to which good should yield its place to the other. We grow tired of long hesitation and inconclusiveness, and the hour may come when we feel that even a bad decision is better than no decision at all. Under these conditions it will often happen that some accidental circumstance, supervening at a particular movement upon our mental weariness, will upset the balance in the direction of one of the alternatives, to which then we feel ourselves committed, although an opposite accident at the same time might have produced the opposite result.

In the *second type* of case our feeling is to a certain extent that of letting ourselves drift with a certain indifferent acquiescence in a direction accidentally determined *from without* with the conviction that, after all, we might as well stand by this course as by the other, and that things are in any event sure to turn out sufficiently right.

In the *third type* the determination seems equally accidental, but it comes from within, and not from without. It often happens, when the absence of imperative principle is perplexing and suspense distracting, that we find ourselves acting, as it were, automatically, and as if by a spontaneous discharge of our nerves, in the direction of one of the horns of the dilemma. But so exciting is this sense of motion after our intolerable pent-up state, that we eagerly throw ourselves into it. "Forward now!" we inwardly cry, "though the heavens fall." This reckless and exultant espousal of an energy so little premeditated by us that we feel rather like passive spectators cheering on the display of some extraneous force than like voluntary agents, is a type of decision too abrupt and tumultuous to occur often in humdrum and cool-blooded natures. But it is probably frequent in persons of strong emotional endowment and unstable or vacillating character. And in men of the world-shaking type, the Napoleons, Luthers, etc., in whom tenacious passion combines with ebullient activity, when by any chance the passion's outlet has been dammed by scruples or apprehensions, the resolution is probably often of this catastrophic kind. The flood breaks quite unexpectedly through the dam. That it should so often do so is quite sufficient to account for the tendency of these characters to a fatalistic mood of mind. And the fatalistic mood itself is sure to reinforce the strength of the energy just started on its exciting path of discharge.

There is a *fourth form* of decision, which often needs deliberation as suddenly as the third form does. It comes when, in consequence of some outer experience or some inexplicable inward charge, *we suddenly pass from the easy and careless to the sober and strenuous mood*, or possibly the other way. The whole scale of values of our motives and impulses then undergoes a change like that which a change of the observer's level produces on a view. The most sobering possible agents are objects of grief and fear. When one of these affects us, all "light fantastic" notions lose their motive power, all solemn ones find theirs multiplied many-fold. The consequence is an instant abandonment of the more trivial projects with which we had been dallying, and an instant practical acceptance of the more grim and earnest alternative which till then could not extort our mind's consent. All those "changes of heart," "awakenings of conscience," etc., which make new men of so many of us, may be classed under this head. The character abruptly rises to another "level," and deliberation comes to an immediate end.

In the *fifth and final type* of decision, the feeling that the evidence is all in, and that reason has balanced the books, may be either present or absent. But in either case we feel, in deciding, as if we ourselves by our own wilful act inclined the beam; in the former case by adding our living effort to the weight of the logical reason which, taken alone, seems powerless to make the act discharge; in the latter by a kind of creative contribution of something instead of a reason which does a reason's work. The slow dead heave of the will that is felt in these instances makes of them a class altogether different subjectively from all the three preceding classes. What the heave of the will betokens metaphysically, what the effort might lead us to infer about a will power distinct from motives, are not matters that concern us yet. Subjectively and phenomenally, the *feeling of effort*, absent from the former decisions, accompanies these. Whether it be the dreary resignation for the sake of austere and naked duty of all sorts of rich mundane delights, or whether it be the heavy resolve that of two mutually exclusive trains of future fact, both sweet and good, and with no strictly objective or imperative principle of choice between them, one shall forevermore become impossible, while the other shall become reality, it is a desolate and acrid sort of act, an excursion into a lonesome moral wilderness. If examined closely, its chief difference from the three former cases appears to be that in those cases the mind at the moment of deciding on the triumphant alternative dropped the other one wholly or nearly out of sight, whereas here both alternatives are steadily held in view, and in the very act of murdering the vanquished possibility the chooser realizes how much in that instant he is making himself lose. It is deliberately driving a thorn into one's flesh; and the sense of *inward effort* with which the act is accompanied is an element which sets the fourth type of decision in strong contrast with the previous three varieties, and makes of it an altogether peculiar sort of mental phenomenon. The immense majority of human decisions are decisions without effort. In comparatively few of them, in most people, does effort accompany the final act. We are, I think, misled into supposing that effort is more frequent than it is, by the fact that *during deliberation* we so often have a feeling of how great an effort it would take to make a decision *now*. Later, after the decision has made itself with ease, we recollect this and erroneously suppose the effort also to have been made then.

EXERCISE

1. Give examples of each of James's "Five types of decision."

10. RATIONALIZATION[1]

BY FREDERIC LYMAN WELLS

The voluntary movements that we make, we regard as indeed "voluntary"; that is, we feel that we act so because we judge it best so to act, and that we could act otherwise if we choose. So deep-rooted is this feeling of the freedom of our actions, that when this is lost, it stands out as a conspicuous symptom of mental disease, where it is known as "ideas of influence," or the "feeling of passivity." This feeling of the independence of our actions seems very closely associated with, perhaps the cause of, another very prominent mental fact, namely, a feeling of motive for our actions. As we control our actions, we want them to have a reasonable motive—man calls himself a rational animal, one that is guided by reason in its conduct. A specific mental adaptation that our acts demand is therefore the assignment of satisfactory motives for them.

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[1] Taken from *Mental Adjustments*, pp. 11–12. New York: D. Appleton & Co., 1917.

The process by which we derive these satisfactory motives is known as rationalization—to rationalize an act means to assign for it a reason satisfactory to ourselves. The first thing to note about rationalization,—wherein it differs as night and day from genuine reasoning governed by experience—is that it is very personal and subjective. John tells us that he threw up his job because his chief did not treat him squarely, but James, whom the chief treated in quite the same manner, does not feel unjustly dealt with. John's rationalization does not give the real cause, which lies in a difference of personality between John and James. James says he does not marry because he gets only twenty-five hundred a year, but most people marry on far less. We must always go further back, and ask, why is that reason so effective with this particular person?

Our rationalizations give a motive which our personality will accept as a fitting one without giving the real cause of our actions. Now the real motives for our conduct often go back to fundamental trends which we have been taught to regard as degraded, that we are base if we act from these motives, and thus our acts are regularly rationalized in the name of some other principle that we have been taught to respect. If our neighbour insults us, we strike him not because we are angry, but because our honor demands it; we refrain from doing so not because we are afraid, but because it would lower our dignity. "How can sin be sin," asks one philosopher, "if through it I rise to spiritual heights before unknown?" Such are our mental adjustments to whatever conduct our pugnacity or our temptations may occasion; just as the fox rationalized his not trying for the grapes on the ground that they were sour.

EXERCISE

1. Indicate some reasons often assigned for coming to college, the choice of friends, and the like, which are not actual motives, but merely results of rationalization.

11. FREEDOM OF CONDUCT[1]

BY HERMANN EBBINGHAUS

As experience of the connections, complications, and consequences of things advances, the ideas called up by any impression must clearly become very numerous. Ideas of near and remote, probable and improbable, desirable and undesirable, consequences,—ideas of fit and unfit, direct and indirect means of bringing about or preventing those consequences,—ideas of difficulties and obstacles, facilities and openings must tend to appear, to compete with each other, to disappear and reappear in rapid succession, or merely to approach consciousness ready to appear when their services should be needed. We refer to these various mental states, according as they appear in one or another form of connection, by such terms as *reflecting*, *considering*, *choosing*, *desiring*, *rejecting*, *intending*, *deciding*, and many others, all having in common the foreseeing of something to be experienced in the future as the result of our action.

What action occurs in each possible case depends on the relative force of the factors coming into play. The actual sensory impression is as a rule a rather insignificant factor. It sets free the ideas derived from innumerable previous sensory impressions. The resulting action is then nearly always extremely different from the instinctive reaction belonging to the sensory stimulation. Such actions, resulting essentially from factors *within* the mind, not from external factors which happen to impress the mind at the moment, are called *free* actions. Their freedom does not mean that they have no causation, that they are free of causes, but they are free of the compulsion exerted by the external stimuli of the moment. They are free actions as opposed to instinctive actions, which are not free of these stimuli of the moment, but on the contrary, completely determined by them.

EXERCISE

1. Discuss the sense in which our conduct is really free.

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[1] Taken from *Psychology: An Elementary Text-Book*, pp. 176–82. (Translated and edited by Max Meyer.) Boston: D. C. Heath & Co., 1908.

CHAPTER XX

PERSONALITY

1. THE BASIS OF PERSONALITY

A[1]

BY GEORGE HOWARD PARKER

To the ancients what we designate as personality was a more or less general attribute of the human body rather than an aggregate of functions having a strictly nervous source. In fact Aristotle, who was such an accurate observer and profound thinker in so many fields of biology, denied positively that the brain was in any direct way concerned with sensation and declared the heart to be the sensorium commune for the whole body. To Galen is ascribed the belief that the brain was the seat of the rational soul, the heart the location of courage and fear, and the liver that of love. This distribution of the element of personality over the physical body finds its expression in the common speech of to-day, particularly in relation to the heart, which is widely accepted by the popular mind as the source of the more tender emotions. It was chiefly through the anatomists and physiologists of the early Renaissance that the modern movement, which has tended to limit personality to the nervous system, was seriously begun, a movement which, with the increase of knowledge, has gained support to such an extent that it can now be maintained beyond any reasonable doubt. Human personality is in no true sense the outcome of the non-nervous organs, such as the digestive or the circulatory organs, but is the direct product of the nervous system. This system, to be sure, is embedded among the other organs of the body and the environment thus provided influences profoundly its condition and action, but what is meant by individual personality, acuteness or dullness of sense, quickness or slowness of action, temperamental traits, such as a gloomy or bright disposition, incapacity, shiftlessness, honesty, thriftiness or sweetness, are all, strictly speaking, functions of the nervous organs. Although only the higher animals can be said to possess personality in this sense, traces of it occur in the lower forms and its evolution is indissolubly connected with that of the nervous system.

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[1] Taken from "The Origin and Evolution of the Nervous System," *Popular Science Monthly*, LXXXIV, (1914), 118.

B[1]

BY TH. A. RIBOT

The organism and the brain, as its highest representation, constitute the real personality, containing in itself all that we have been, and the possibilities of all that we shall be. The complete individual character is inscribed there with all its active and passive aptitudes, sympathies, and antipathies; its genius, talents, or stupidity; its virtues, vices, torpor, or activity. Of all these, what emerges and actually reaches consciousness is only a small item compared with what remains buried below, albeit still active. Conscious personality is always but a feeble portion of physical personality.

The unity of the ego, consequently, is not that of the one-entity of spiritualists which is dispersed into multiple phenomena, but the co-ordination of a certain number of incessantly renascent states, having for their support the vague sense of our bodies. This unity does not pass from above to below, but from below to above; the unity of the ego is not an initial, but a terminal point.

Does there really exist a perfect unity? Evidently not in the strict, mathematical sense. In a relative sense it is met with, rarely and incidentally. In a clever marksman in the act of taking aim, or in a skilled surgeon performing a difficult operation, all is found to converge, both physically and mentally. Still, let us take note of the result: in these conditions the awareness of real personality disappears; the conscious individual is reduced to an idea; whence it would follow that perfect unity of consciousness and the awareness of personality exclude each other. By a different course we again reach the same conclusion; the ego is a co-ordination. It oscillates between two extreme points at which it ceases to exist: viz. perfect unity and absolute incoördination. All the intermediate degrees are met with in fact, and without any line of demarcation between the healthy and the morbid; the one encroaches upon the other.[2]

The unity of the ego, in a psychological sense, is, therefore, the cohesion, during a given time, of a certain number of clear states of consciousness, accompanied by others less clear, and by a multitude of physiological states which without being accompanied by consciousness like the others, yet operate as much and even more than the former. Unity, in fact, means co-ordination. The conclusion to be drawn from the above remarks is namely this, that the consensus of consciousness being subordinate to the consensus of the organism, the problem of the unity of the ego is, in its ultimate form, a biological problem. To biology pertains the task of explaining, if it can, the genesis of organisms and the solidarity of their component parts. Psychological interpretation can only follow in its wake.

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[1] Taken from *The Diseases of Personality*, pp. 156–57. (Authorized translation.) Chicago: Open Court Publishing Co., 1891.

[2] Even in the normal state the co-ordination is often sufficiently loose to allow several series to co-exist separately. We can walk or perform manual work with a vague and intermittent consciousness of the movements, at the same time singing, musing: but if the activity of thought increases, the singing will cease. With many people it is a kind of substitute for intellectual activity, an intermediate state between thinking and not-thinking.

EXERCISES

1. How much truth was there in the ancient belief that personality is a "more or less general attribute of the human body rather than an aggregate of functions having a strictly nervous source"?
2. Cite illustrations to demonstrate that your moments of maximum co-ordination are not your moments of maximum self-consciousness.

2. DEVELOPMENT OF PERSONALITY[1]

BY EDWIN GRANT CONKLIN

No intelligent person doubts that man is an animal, a vertebrate, a mammal, although there are some people who hesitate to accept that classification. The late John Fiske used to tell of a man who became very indignant when told that he was a mammal and replied, "I am not a mammal nor the son of a mammal"; he explained that he had probably been brought up on a bottle. No well informed person doubts that heredity, development and evolution apply to man as well as to all other living things, and yet I have known people who granted only grudgingly that man develops from a fertilized egg or that heredity has any part in the development of mind or soul, while they rejected altogether the conclusion that evolution applies to man. Such persons are influenced by sentiment rather than by evidence and it is useless to attempt to convince them by an appeal to facts, while those trained in science do not need to be convinced of these elemental truths.

"Development," said Karl Ernst von Baer, "is a veritable torchbearer in the study of organic bodies." This is true of the study of the entire personality of man, of the mind as well as of the body, for as the body of man develops out of the structures of the fertilized egg, so the mind of man develops out of the functions of the egg.

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[1] Adapted from *Proceedings of the American Psycho-Medical Association* (1917), pp. 213-17.

The psychical processes which are present in germ cells and embryos are the following: (1) Differential sensitivity, or different responses to different kinds of stimuli, (2) Tropisms or simple mechanical movements toward or away from a source of stimulus, (3) Organic memory or the results of previous experiences registered in the general protoplasm, (4) Useful responses which are the results of elimination of useless responses through trial and error, (5) Varying responses dependent upon conflicting stimuli and physiological states, (6) Identity or continuity of individual organisation. Out of these elementary psychical processes develop in the higher animals and man: (1) Special senses and sensations, (2) Reflexes, instincts, and habits, (3) Associative memory, (4) Intelligence, (5) Inhibition, choice, and will, (6) Consciousness, dependent upon continuity of memory, intelligence, reason, will.

In the development of personality as in the development of any organic structure there is no creation *de novo*, but merely a transformation of parts and functions already present in the germ. New things appear in the course of development by a process of *creative synthesis*, for just as hydrogen and oxygen when they combine form water which was not present in either of its elements, so the germinal functions of sensitivity, tropism, organic memory, trial and error, persistence of organization, etc., when all cooperate, produce by a process of creative synthesis something which was not present before, viz., *consciousness*.

The factors or causes of development, whether of the body or of the mind, are found both in the germ cells and in surrounding conditions, or, in other words, in heredity and in environment. Heredity is on the whole a more important factor than environment; it determines all the possibilities of development and all its main results, whereas environment serves chiefly to modify these results.

One of the greatest discoveries made in biology is that of Gregor Mendel, that the characters of an organism are derived from the father *or* from the mother, and that the germinal causes of these characters, the genes, separate in the formation of the germ cells so that one germ cell will carry the inheritance units or genes for certain paternal characters and another for corresponding maternal characters; finally when male and female germ cells from different individuals unite in fertilization a new combination of genes results, thus giving rise to a new individual.

The principles of Mendel make it possible to analyze an individual into many characters that are hereditarily separable and to follow these separate or unit characters through many generations. Some characters, such as blue or brown eyes, straight or curly hair, etc., are simple and it is relatively easy to determine the precise manner in which they are inherited; other characters such as skin color, size or stature, etc., are more complex and it is more difficult to determine their method of inheritance, and in general the more complex a character is the more difficult it is to determine its mode of inheritance. Nevertheless, whenever a complex character can be analyzed into its simple constituents the latter are always found to be inherited in Mendelian fashion.

But while the mode of *transmission* of the inheritance factors or genes for unit characters is a relatively simple matter, the *development* of even the simplest character is inconceivably complex, depending upon the interaction of very many germinal and environmental causes. For example, it is known that the differences in structures, functions and instincts between queen bees and worker bees are due to the character of the food given to the larvae. In the case of man and other higher animals the presence of internal secretions from the thyroid, thymus, pituitary, sex glands, etc., exercises a profound influence on the development both of the body and the mind: All such influences are, strictly speaking, environmental, since they are not due to the constitution of the germ cells, but to conditions outside of these cells.

In man, training, education and social conditions also exercise a profound influence on the development of mind and personality. Indeed, heredity determines merely the possible limits of development, while environment and education determine the actual results which will be realized within these limits.

Recent studies have shown that the development of such simple characters as eye color and sex are exceedingly complex and that very many factors have been involved in the process. When we come to the development of more complex things such as temperament, feeble-mindedness, insanity, personality, we are dealing with the most complex phenomena in all the world—inconceivably more complex than any of the problems of astronomy, physics or chemistry. If eye color in the fruit fly is dependent upon a large number of inheritance factors, as Morgan and his pupils have shown to be the case, how much more probable is it that epilepsy, feeble-mindedness, genius and insanity are dependent upon a still larger number of inheritance factors, as well as upon an innumerable number of environmental causes. We may be sure that when the whole "alphabet of degeneracy from alcoholism to wanderlust" is attributed to the lack of a single hereditary factor, there has been a pitiful failure to recognize the complexity of the phenomena in question.

Particularly in the study of the development of mental and moral traits there is great need of caution against oversimplification. The web of hereditary, environmental and educational causes is so intricate that it is often impossible to decide whether a given trait is inherited or not, and it is usually impossible to predict what the character of offspring will be. Some very unpromising stocks, some most untoward environments, have produced wonderful results. When we remember that Beethoven's mother was a consumptive and his father a confirmed drunkard; that Michael Faraday, perhaps the greatest scientific discoverer of any age, was born over a stable, his father a poor, sick blacksmith and his mother unable to read or write, that the only early education he had was obtained in selling newspapers on the streets of London and later in working as apprentice to a bookbinder; that Lincoln's father was a ne'er-do-well, and his early surroundings and education most unpromising; that George W. Child was a nameless foundling, and so on through the long list of names in which democracy glories—when we remember these world-famous men and when we reflect that eugenicists and birth-controllers would have deprived the world of these superlative geniuses if they could have had their way, we may well inquire whether it is not fortunate that we are in the hands of an all-wise Providence rather than of an unwise propaganda.

This is not to say that these and other geniuses have not developed according to definite laws. It is no miracle that Lincoln should have

"Burst his birth's invidious bar,

. . . .

And mounting up from high to higher,
Become on fortune's crowning slope
The pillar of a people's hope,
The center of a world's desire."

But the processes by which genius is produced are extremely complex and at present we are just beginning to learn about them. Undoubtedly the factors or causes of all kinds of development are found in heredity and environment, but with regard to the development of the most complex thing in all the world, viz., human personality, we are as children in the morning of time.

3. THE MAKE-UP OF SELF-CONSCIOUSNESS

A[1]

BY WILLIAM JAMES

THE SELF AS KNOWN

The Empirical self or me.—Between what a man calls *me* and what he simply calls *mine* the line is difficult to draw. We feel and act about certain things that are ours very much as we feel and act about ourselves. Our fame, our children, the work of our hands, may be as dear to us as our bodies are, and arouse the same feelings and the same acts of reprisal if attacked. And our bodies themselves, are they simply ours, or are they *us?* Certainly men have been ready to disown their very bodies and to regard them as mere vestures, or even as prisons of clay from which they should some day be glad to escape.

We see then that we are dealing with a fluctuating material; the same object being sometimes treated as a part of me, at other times as simply mine, and then again as if I had nothing to do with it at all. *In its widest possible sense*, however, *a man's Me is the sum total of all that he* CAN *call his*, not only his body and his psychic powers, but his clothes and his house, his wife and children, his ancestors and friends, his reputation and works, his lands and horses, and yacht and bank-account. All these things give him the same emotions. If they wax and prosper, he feels triumphant; if they dwindle and die away, he feels cast down,—not necessarily in the same degree for each thing, but in much the same way for all.

The constituents of the Me may be divided into three classes, those which make up respectively—

The material me;
The social me; and
The spiritual me.

The material me.—The *body* is the innermost part of the material me in each of us; and certain parts of the body seem more intimately ours than the rest. The clothes come next. The old saying that the human person is composed of three parts,—soul, body and clothes—is more than a joke. We so appropriate our clothes and identify ourselves with them that there are few of us who, if asked to choose between having a beautiful body clad in raiment perpetually shabby and unclean, and having an ugly and blemished form always spotlessly attired, would not hesitate a moment before making a decisive reply. Next, our immediate family is a part of ourselves. Our father and mother, our wife and babes, are bone of our bone and flesh of our flesh. When they die, a part of our very selves is gone. If they do anything wrong, it is our shame. If they are insulted, our anger flashes forth as readily as if we stood in their place. Our home comes next. Its scenes are part of our life; its aspects waken the tenderest feelings of affection; and we do not easily forgive the stranger who, in visiting it, finds fault with its arrangements or treats it with contempt. All these different things are the objects of instinctive preferences coupled with the most important practical interests of life. We all have a blind impulse to watch over our body, to deck it with clothing of an ornamental sort, to cherish parents, wife, and babes, and to find for ourselves a house of our own which we may live in and "improve."

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[1] Adapted from *Psychology*, Briefer Course, pp. 176–81. New York: Henry Holt & Co., 1892.

An equally instinctive impulse drives us to collect property; and the collections thus made become, with different degrees of intimacy, parts of our empirical selves. The parts of our wealth most intimately ours are those which are saturated with our labor. There are few men who would not feel personally annihilated if a life-long construction of their hands or brains—say an entomological collection or an extensive work in manuscript—were suddenly swept away. The miser feels similarly towards his gold; and although it is true that a part of our depression at the loss of possessions is due to our feeling that we must now go without certain goods that we expected the possessions to bring in their train, yet in every case there remains, over and above this, a sense of the shrinkage of our personality, a partial conversion of ourselves to nothingness, which is a psychological phenomenon by itself. We are all at once assimilated to the tramps and poor devils whom we so despise, and at the same time removed farther than ever away from the happy sons of earth who lord it over land and sea and men in the full-blown lustihood that wealth and power can give, and before whom, stiffen ourselves as we will by appealing to anti-snobbish first principles, we cannot escape an emotion, open or sneaking, of respect and dread.

The social me.—A man's social me is the recognition which he gets from his mates. We are not only gregarious animals, liking to be in sight of our fellows, but we have an innate propensity to get ourselves noticed, and noticed favorably, by our kind. No more fiendish punishment could be devised, were such a thing physically possible, than that one should be turned loose in society and remain absolutely unnoticed by all the members thereof. If no one turned round when we entered, answered when we spoke, or minded what we did, but if every person we met "cut us dead," and acted as if we were non-existing things, a kind of rage and impotent despair would ere long well up in us, from which the cruellest bodily tortures would be a relief; for these would make us feel that, however bad might be our plight, we had not sunk to such a depth as to be unworthy of attention at all.

Properly speaking, *a man has as many social selves as there are individuals who recognize him* and carry an image of him in their mind. To wound any one of these his images is to wound him. But as the individuals who carry the images fall naturally into classes, we may practically say that he has as many different social selves as there are distinct *groups* of persons about whose opinion he cares. He generally shows a different side of himself to each of these different groups. Many a youth who is demure enough before his parents and teachers, swears and swaggers like a pirate among his "tough" young friends. We do not show ourselves to our children as to our club-companions, to our customers as to the laborers we employ, to our own masters and employers as to our intimate friends. From this there results what practically is a division of the man into several selves; and this may be a discordant splitting, as where one is afraid to let one set of his acquaintances know him as he is elsewhere; or it may be a perfectly harmonious division of labor, as where one tender to his children is stern to the soldiers or prisoners under his command.

The most peculiar social self which one is apt to have is in the mind of the person one is in love with. The good or bad fortunes of this self cause the most intense elation and dejection—unreasonable enough as measured by every other standard than that of the organic feeling of the individual. To his own consciousness he *is* not, so long as this particular social self fails to get recognition, and when it is recognized his contentment passes all bounds.

A man's *fame*, good or bad, and his *honor* or dishonor, are names for one of his social selves. The particular social self of a man called his honor is usually the result of one of those splittings of which we have spoken. It is his image in the eyes of his own "set," which exalts or condemns him as he conforms or not to certain requirements that may not be made of one in another walk of life. Thus a layman may abandon a city infected with cholera; but a priest or a doctor would think such an act incompatible with his honor. A soldier's honor requires him to fight or to die under circumstances where another man can apologize or run away with no stain upon his social self. A judge, a statesman, are in like manner debarred by the honor of their cloth from entering into pecuniary relations perfectly honorable to persons in private life. Nothing is commoner than to hear people discriminate between their different selves of this sort: "As a man I pity you, but as an official I must show you no mercy"; "As a politician I regard him as an ally, but as a moralist I loathe him"; etc., etc. What may be called "club-opinion" is one of the very strongest forces in life. The thief must not steal from other thieves; the gambler must pay his gambling-debts, though he pay no other debts in the world. The code of honor of fashionable society has throughout history been full of permissions as well as of vetoes, the only reason for following either of which is that so we best serve one of our social selves. You must not lie in general, but you may lie as much as you please if asked about your relations with a lady; you must accept a challenge from an equal, but if challenged by an inferior you may laugh him to scorn: these are examples of what is meant.

The spiritual me.—By the "spiritual me," so far as it belongs to the empirical self, I mean no one of my passing states of consciousness. I mean rather the entire collection of my states of consciousness, my psychic faculties and dispositions taken concretely. This collection can at any moment become an object to my thought at that moment and awaken emotions like those awakened by any of the other portions of the Me. When we *think of ourselves as thinkers*, all the other ingredients of our Me seem relatively external possessions. Even within the spiritual *Me* some ingredients seem more external than others. Our capacities for sensation, for example, are less intimate possessions, so to speak, than our emotions and desires; our intellectual processes are less intimate than our volitional decisions. The more *active-feeling* states of consciousness are thus the more central portions of the spiritual Me. The very core and nucleus of our self, as we know it, the very sanctuary of our life, is the sense of activity which certain inner states possess. This sense of activity is often held to be a direct revelation of the living substance of our Soul. Whether this be so or not is an ulterior question. I wish now only to lay down the peculiar *internality* of whatever states possess this quality of seeming to be active. It is as if they *went out to meet* all the other elements of our experience. In thus feeling about them probably all men agree.

B[1]

BY JOSIAH ROYCE

In its inner aspects and relations, what we mean by self-consciousness, in any one man, is an enormously complex function or rather a little world of functions. But this world of functions is centred about certain well known habits and experiences which at once serve, not to explain it, but in a measure to begin for us the definition of our problem. There are, namely, in any mature person, certain established motor habits, which, according as they appear to be intact or not, enable us at once to test, from without, the relative normality of whatever belongs to that which one may call the mere routine of an individual's self-consciousness. There are also certain inner experiences, in terms of which the normal individual himself, from moment to moment, can feel assured of the apparent naturalness of his own notion or estimate of himself. A mature man whose self-consciousness is normal, if his means of expressing himself are intact, must be able to explain "who he is," i.e., he must be able to tell his name, his business, his general relations in life, and whatever else would be essential to the practical purpose of identifying him. Furthermore, his account of himself must be able to show an estimate by no means adequate or infallible, but at least not too wildly absurd, of his actual degree of social dignity, of his personal importance and of his physical capacity. He will, to be sure, quite normally estimate his value, his prowess, or even his social rank, not, in general, precisely as his fellows do. But this sort of estimate has its normal, if rather wide, limits of error. If these limits are passed, the man's account of himself proves the presence of a derangement of self-consciousness. Finally, as to this account which the normal man can give of himself, he must show a certain degree of correctness as to what he can tell us of his body and of its present state. Here, of course, the limits of error are very wide, but are still pretty definite. A man is normally a very poor judge of his internal bodily states. But if he says he is made of glass, or that he is aware that he is a mile high, or that he is conscious of having no body at all, we recognize a disorder involving alterations of self-consciousness.

Within his own mind, meanwhile, and from his own point of view, a man normally self-conscious is more or less aware of a great deal about himself of which it is notoriously hard for him to give any exact account whatever. Yet this internally normal self-consciousness has, at any time, a definitive, if not easily definable content, which, in its relatively inexpressible complexity of constitution, far transcends what one expresses when he tells you his name, his place in life, his *status*, or his notion of his bodily condition. This normal inner self-consciousness involves, in the first place, what we are now accustomed to call, from a psychological point of view, masses of somewhat vaguely localized bodily sensations, which, just in so far as they affect our general consciousness, are not sharply differentiated from one another. The origin of these sensations lies in the skin, in the muscles, and, in part, in the viscera. Moreover, the visual perception of the body, the auditory experiences of the sound of one's own voice, and yet other sensory contents, including the more general sensations of bodily movement, obviously determine, now more, and now less, the content or the coloring of normal self-consciousness. If any of these masses of sensory contents are suddenly altered, our immediate self-consciousness may be much changed thereby. Dizziness, sensations of oppression in the head, a general sense of bodily ill-being, a flushed face, a ringing in the ears,—any of these may involve what we primarily take to be a general alteration of our feeling of self, and only secondarily distinguish from the self as a separate and localized group of experiences. In general, the more sharply we localize our sensations, and the more we refer them to external objects, the less do these sensory experiences blend into our total immediate feeling of ourselves. The localized or objectified sensory state appears as something foreign, as coming to us, as besetting us, or as otherwise affecting us, but not as being a part of the self; and only a relatively philosophical reflection regards even our perceptions as part of ourselves. Our more naïve self-consciousness tends to regard the sensory or immediate self as a vague whole, from which one separates one's definite experiences of this place on the skin, of this color or tone, or of this outer object.

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[1] Taken from *Studies of Good and Evil*, pp. 170–76. New York: Appleton & Co., 1898.

Yet our inner notion of the self of self-consciousness is by no means confined to this cruder appreciation of massive sensory contents. In addition, our normal mature awareness of who and what we are means what one may call a collection of feelings of inner control, of self-possession, or, as many would say, of spontaneity. If such feelings begin to be altered or lost, one complains of confusion, of a sense of self-estrangement, of helplessness, of deadness, of mental automatism, or of a divided personality. As a fact, since the associative processes always depend upon the conditions of which we are not conscious, our sense that we can and do rule our whole current train of conscious states is, as it is ordinarily felt, a fallacious sense. But if we cannot really predetermine, in consciousness, what idea shall next come to consciousness, but are dependent, even in the clearest thinking, upon the happy support of our associative mechanism, it is still normal to feel as if, on the whole, our inner process were, in certain respects, relatively spontaneous, i.e., as if it were controlled by our ruling interests and by our volition. This sense of inner self-possession is, to be sure, an extremely delicate and unstable affair, and is constantly interfered with, in the most normal life, not only by a series of uncontrollable sensory novelties, due to the external world, but by baffling variations, either in the play of our impulses and ideal associations, or in the tone of our emotions, or in both. Yet, when we are alert, these little interferences continually arise only to be subordinated. We have perhaps momentary difficulties in recalling names or other needed ideas, of an imperfectly learned group, or we feel equally momentary indecisions as to what it is just now best to do, or we find our attention wandering, or our emotional tone disagreeably insistent, or our impulses numerous and wayward. But in all such cases we can still, in the normal case, "keep hold of ourselves," so that we accept as our own whatever content triumphs in the play of associative processes, and find our essential expectations met, from moment to moment, by the inner experiences which form the centre of the mental field of vision. If this rule no longer holds to our inner life, then our self-consciousness begins to vary, and we suffer from confusion or from other forms of the sense of lost inner control.

Thus the self of ordinary self-consciousness appears at once as a relatively stable group of unlocalized sensory contents or contents of feeling, and as the apparent controller of the train of associated ideas, impulses, and acts of attention or of choice. Of course these two aspects of the self are closely related. It is the associative potency of the ruling feelings and interests that most secures the fact and the sense of inner self-control. But meanwhile the self also seems, or may seem, to its possessor, much larger than any group of facts or of functions now present. One notoriously regards the present self as only the representative of a self which has been present, in the remembered past of our lives, and which will be present in the expected future to which we look forward. Nor does self-consciousness usually cease with this view. The characters, attributes, functions, or other organic constituents of the self commonly extend, from our own point of view, decidedly beyond anything that can be directly presented in any series of our isolated inner experiences, however extended. When one is vain, one's self-consciousness involves the notion that one's self really exists, in some way or other, for the thoughts and estimates of others, and is at least worthy, if not the possessor, of their praise or of their envy. When one feels guilty, one does not and cannot abstract from the conceived presence of one's self in and for the experience of a real or ideal judge of one's guilt. In all such cases the self or self-consciousness thus appears as something that it would not and could not be were there not others in the world to behold, or to estimate it, to be led or otherwise influenced by it, or to appeal to it. It is now from such points of view that the self of self-consciousness comes, in the end, to get form as a being who takes himself to have a social position, an office, a profession,—in brief, a vast group of functions without which the self would appear itself to be, relatively speaking, a mere çipher, while these functions are at once regarded as organically joined to the self, and centered in it, and, nevertheless, are unintelligible unless one goes beyond one's private consciousness, and takes account of the ideas and estimates of other people.

Every normal man thus knows what it means to be a person with a social position, or a dignity, or a place in the world, or a character, a person vain of himself, or ashamed of himself, or socially confident or timid about himself, or otherwise disposed to view himself either as others seem to view him, or as he fancies that they ought to view him, or as he has faith that God views him. And such a view of one's self cannot be satisfied with any group of inner facts however extensive, as containing within it the whole of one's ego. This view conceives the office, calling, dignity, worth, position, as at once, a possession, or a real aspect, of the self, and as a possession or an aspect that would vanish from the world were not the self conceived as existing for others besides itself, in other words, were not the self conceived as having an exterior as well as interior form of existence.

The self of normal self-consciousness, then, is felt at any moment as this relatively stable group of inner states; it is also felt or conceived as the supposed spontaneous controller of the general or of the principal current of successive conscious states; it is remembered or expected as the past or future self, which is taken to be somehow more or less precisely the same as the present self; and finally, it is viewed as having a curious collection of exterior functions that involve its actual value, potency, prowess, reputation, or office, in its external social relations to other actual or ideal selves, e.g., to its neighbors, to humanity at large, or, in case one's faith extends so far, to God.

And, now, just as the immediate self of the mass of inner sensations and feelings can vary, or just as the self of the sense of self-control can be more or less pathologically altered; so too the identical or persistent self of memory can be confused, divided, or lost, in morbid conditions; and so too finally, the self of the social type of self-consciousness is subject to very familiar forms of diseased variation. The social self above all can come to be the object of a morbidly depressed or exalted inner estimate. One's social prowess, position, office and other relations, both to God and to man, can be conceived in the most extravagantly false fashions. And furthermore, as I wish at once to point out, the most noteworthy alterations of self-consciousness, in insanities involving delusions of suspicion, of persecution and of grandeur, appear upon their very surface as pathological variations of the social aspect of self-consciousness. Note at once the possible significance of this fact. However you explain delusions of guilt, of suspicion, of persecution and of grandeur, however much you refer their source to altered sensory or emotional states, they stand before you, when once they are well developed, as variations of the patient's habits of estimating his relations to other selves. They involve, then, *maladies of the social consciousness.* The theoretical significance of this fact surely seems worthy of a closer consideration than it customarily receives.

EXERCISES

1. Why is your work, for instance, sometimes a more intimate element in your self than at other times?
2. Why are the most noteworthy alterations of personality variations of the *social* aspect of self-consciousness?

4. THE DEVELOPMENT OF SELF-CONSCIOUSNESS[1]

BY JOSIAH ROYCE

The early intellectual life of the child is lost to us in obscurity, despite numerous recent observations. But we are clear that the infant, in the first months of life, has nothing that we should call self-consciousness. The first clear evidence that we get of the presence of a form of self-consciousness intelligible to us comes when the infant begins to be observantly imitative of the acts, and later of the words, of the people about it. In other words, the first Ego of the child's intelligible consciousness appears to be, in its own mind, set over against a non-Ego that, to the child, is made up of the perceived fascinating, and to its feeling more or less significant, deeds of the persons in its environment. From this time on, up to seven or eight years of age, any normal child remains persistently, although perhaps very selectively, imitative, of deeds, or habits, of games, of customs, and often of highly ideal and perhaps quite imaginary models, such as are suggested to it by fairy-stories and other such material. As one follows the growth of these imitative tendencies, from their initial and quite literal stages, through those stages of elaborate impersonation and of playful, originally colored, often enormously insistent games, in which the child follows all sorts of real and fantastic models, one is struck by the fact that any normal child leads, relatively speaking, two lives, one naïve, intensely egoistic from our point of view, but relatively free from any marked self-consciousness in the child's own mind, while his other life is the life in which he develops his conscious ideas and views of himself as a person. The relatively naïve life is the life of his childish appetites and passions; the relatively self-conscious life is the life of his imitations and dramatic impersonations, of his poses and devices, of his games, and of his proudly fantastic skill, and of the countless social habits and attitudes that spring up from this source. The two lives mingle and cross in all sorts of ways. But the child who merely eats, cries, and enjoys his physical well-being, is not just then self-conscious as is the child who plays horse, or hero, or doctor, or who carefully tries to follow a model as he draws, or to invent a trick as good as one that he has seen. The latter child, however, is essentially imitative, first of persons, then of ideas, then of the facts of the physical world as such. But the former child is simply the creature of natural impulses and passions, and would never come to self-consciousness, in our sense, if his life were not gradually moulded by the elaborate habits which the imitative child constantly introduces.

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[1] Taken from *op. cit.*, pp. 182–87.

Now the psychological importance of imitation lies largely in the fact, that in so far as a child imitates, he gets ideas about the inner meaning or intent of the deeds that he imitates, and so gets acquainted with what he early finds to be the minds of other people. The child that repeats your words, slowly learns what they mean. The child that uses scissors, pencil, or other tools after you, learns, as he imitates, what cutting means, and what drawing, or other such doings. And as he thus learns, he gets presented to his own consciousness contents, which he regards as standing for those of your mind. The experienced interesting outcome of an imitated deed, is for the child the obvious meaning of that deed, for you, as you did it. But he does not get these contents—these glimpses of your meaning—he does not get them, at first very easily. He gets them by persistently watching you, listening to you, playing with you, trying to be like you—all activities that for him involve muscular sensations, emotional concerns, and still other variations of his common sensibility. These efforts of his to grasp your meaning are marked and often delightful incidents of his consciousness. He returns over and over to his favorite games with you. He encounters every time your meaning, and he sets over against it those experiences of his own doings, whereby he comes to participate in your meaning. Here now the child always has present to him two sets of contents, both fascinating, each setting the other off sharply by contrast, while the contrast itself establishes the boundary between them. The first set of contents are his perceptions of your deeds, and his representation of your discovered meaning in these deeds. The second set of contents are his own imitative acts themselves, as perceived by himself, these acts, and his delights in them. The first set of contents depend upon you. The child feels them to be uncontrollable. As perceptions, and as representations, these contents do not get closely linked to the child's common sensibility. They stand off as external although welcome intruders. On the other hand, the other set of contents, the child's own newly discovered powers, due to his imitation, are closely centered about his common sensibility, are accompanied with all the feelings which make up the sense of control, and get remembered, thenceforth, accordingly. The first set of contents form the psychological non-Ego of this particular phase of consciousness. The second set of contents form the psychological Ego corresponding thereto. One sees why the Ego-part of this sort of consciousness included the common sensibility, and the sense of voluntary control, and why the non-Ego here involves contents that are set off by the contrast as uncontrollable, and as not closely linked to the common sensibility. And it is in this contrast that the source of true self consciousness lies. We do not observe a given group of mental contents as such unless they are marked off by contrast from other contents. One could have all the common sensibility you please, and all the feelings of voluntary control, without ever coming to take note of this totality of united or centralized mental contents as such, and as clearly different from the rest of one's field of consciousness. Even now we all of us tend to lose clear self-consciousness so soon as we get absorbed in any activity, such as rowing, hill-climbing, singing, whistling, looking about us at natural scenery—any activity I say, whose object does not, by the sharp contrast between its own external meaning and our efforts, call our attention to our specific relation to some non-Ego. Yet in lonely rowing and hill-climbing the common sensibility is as richly present as it is in many of our most watchfully self-conscious states. On the other hand, when I work hard to make my meaning clear to another man, or to make out what he means, I am self-conscious, just in so far as I contrast my idea of his ways and thoughts, with my own effort to conform to his ways and thoughts. And just such an effort, just such a contrast, seems to mediate the earliest self-consciousness of the imitative child, and to secure the tendency of the self to be built up about the common sensibility, while the not self gets sundered therefrom. So then one sees the rule: If one is keenly self-conscious, the common sensibility must be central. But, on the other hand, one may have a rich common sensibility without any keen self-consciousness. It is the contrast of Ego and non-Ego that is essential to self-consciousness.

But of course the child's relations to the varying non-Ego of consciousness do not remain merely imitative. When once he has other minds in his world, the function whose essence is the contrast between his conceptions of these minds and his view of his own response to them can take as many forms as his natural instincts determine. His naïve life of appetites gets gradually infected by his conscious relations to other people. He wants good things, and perhaps must feign affection or show politeness, or invent some other social device, to get what he wants. Here again is an activity depending upon and bringing to light, the contrast between his own intention, and the conceived or perceived personal traits and whims to which he conforms his little skill. He learns to converse, and gets a new form of the contrast between the sayings of others (which he interprets by listening), and his own ideas and meanings. He reaches the questioning age, and now he systematically peers into the minds of others as into an endlessly wealthy non-Ego, in whose presence he is by contrast self-conscious as an inquirer. Here, every time one has the essential element of contrast upon which all self-consciousness depends. Argument and quarreling later involve similar contrasts. As to the external physical world—what the child shall most care for in that, is largely determined for him by his social relations. Whatever habit he has acquired by social imitation, he can, therefore, in the end, apply to things as well as to persons. As a fact he is notoriously often animistic, directly transferring social habits to physical relations, and regarding things as alive. And here again he becomes self-conscious, by contrasting his own activities with the conceived natures and meanings of external things. I do not at all suppose that the child regards all natural things in an animistic way; but I am of opinion, for reasons which I have set forth elsewhere, that our whole tendency to distinguish as sharply, as we all now do, between the self and the external physical world, is a secondary tendency, due in the child's case, to social influences. It is language, it is the accounts that people give to us of things, it is the socially acquired questioning habit—it is such things that extend the contrast between Ego and non-Ego, at first mainly a social contrast, to the relations between one's own mind and one's physical environment. Even now, as I just pointed out, if we forget that nature is full of thinkable mysteries, of meanings, of laws, of other ideal contents whose significance we do not comprehend—if we forget this, and lapse into mere busy and absorbing physical experience, as when climbing hills alone, or rowing, or cheerily whistling as we walk, we forget to be self-conscious, just because we lose sight of the sharper contrasts of Ego and non-Ego.

EXERCISE

1. Show the extent to which the following statement is incomplete or erroneous: "We learn to know others by first learning about ourselves and then interpreting others in terms of ourselves."

5. SOCIAL CONSCIOUSNESS

A[1]

BY MARGARET FLOY WASHBURN

Social psychology has for the most part been written in terms of behavior. It is the purpose of this paper to point out that the profound and striking differences which exist between the social psychology of man and that of the lower animals as a class are due to the presence in man of a factor which can be most concisely described in introspective terms. This factor I have called, for brevity of reference, *ejective consciousness:* it is the awareness of thoughts and feelings as belonging to other minds than our own, the awareness of the contents of other people's minds. I shall not here attempt an introspective analysis of ejective consciousness. In a paper[1] published fourteen years ago I discussed the possibility of such an analysis, but the contents of that paper need not be resurrected now either for reaffirmation or for repudiation. Ejective consciousness has doubtless like all consciousness a motor or behavioristic basis. When we think of a thought as belonging to another person, we have probably present a motor attitude unlike that which exists when we think of the same thought as belonging to ourselves. But the difference between the two states of mind, "I think or feel so and so," and "He thinks or feels so and so," is discoverable by introspection; and by noting its presence and absence, its more and less developed forms as a conscious experience, we can get much light on the modifications of social behavior.

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[1] Taken from *Studies in Psychology* (1917), pp. 11–17, by colleagues and former students of Edward Bradford Titchener.

First of all, it is clear that social behavior precedes ejective consciousness in the course of evolution. Animals are capable of acting socially, that is, of making specialized responses to other animals as stimuli, at a much lower stage of development than sees the dawn of the ability to realize consciously another's state of mind. We often observe parental behavior in the lower animals which we cannot interpret as being accompanied by any conscious realization of the feelings of the offspring. Ejective consciousness in its developed form demands the power of imagination: it involves reference to stimuli that are not capable of present action on the sense-organs. Granting then, that the capacity for social behavior exists before ejective consciousness is developed, and that the lower animals have a social psychology which can be described in terms of behavior without introducing this factor which is most immediately known through introspection, let us proceed to the discussion of the three questions with which this paper will immediately concern itself. First, which forms of social behavior have contributed most to the rise of ejective consciousness? Secondly, what has been the effect of ejective consciousness on social behavior? Thirdly, what features have marked the development of ejective consciousness itself? These are large questions, and our answers will be as briefly stated as possible.

First, since it is only on the basis of our own inner experience that we can interpret the inner experience of others, it becomes clear that the greatest contribution to the development of ejective consciousness will come from those forms of social behavior where individuals perform like functions. We shall not expect that either sex behavior or

[1] *American Journal of Psychology*, XIV, 1903, 337–42.

parental behavior will contribute greatly to the development of the power to interpret other minds. They may, especially the latter, contribute greatly to altruism, but altruism, as life teaches us to our cost, is not sympathy. No type of conduct in which we act towards our fellows as they are not expected to act towards us will develop understanding of their minds. In parenthood and in sex relations the individuals concerned have different functions, and cannot be expected to understand each other. Such types of social behavior as involve equality and similarity of conduct among the individuals of a group are obviously the types in which sympathetic understanding, ejective consciousness, will earliest develop. Thus the gregarious instinct and the instinct (for I would still so term it despite McDougall and Thorndike) of imitation are the forms of social behavior which probably contribute most to the rise of ejective consciousness.

Secondly, what is the effect of ejective consciousness, as it develops, upon the social behavior which formed the pre-existent soil for its growth? The effect may be summed up, I think, in one sentence: ejective consciousness substitutes mental for physical causes of social behavior. Let us consider various types of social behavior and test the truth of this statement. The gregarious instinct has in the lower animal forms various external stimuli. In Protozoa apparently the carbon dioxide which the animals excrete is responsible for their gathering into aggregations; Small, observing the instinct of baby rats to pile themselves into heaps, suggested that the desire for warmth may be the root of the social instinct; the comfortable smell of one's fellow-beings, the safe and accustomed sights and sounds due to their presence, incite the grouping of higher animals. Man, on the other hand, with better developed ejective consciousness, can find little comfort in the society of persons whose mental processes he interprets as wholly unlike his own. The society of an imbecile would be worse than solitude. The self-exhibiting instinct is stimulated in man rather by what he imagines other people are thinking of him than by any external stimuli. It becomes a strong ally of the gregarious instinct: whether the individual concerned is a woman going to an afternoon reception or a man seeking conversation at a corner grocery, the desire to see oneself favorably reflected in the minds of others, whether on account of one's clothes or one's arguments, is a powerful incentive. The imitative instinct becomes so altered by ejective consciousness that its chief stimulus is not the outward actions of others, but what we conceive to be their mental states, their "beliefs and desires," as

Tarde put it. The instincts of sex and parenthood, as befits those which have done least for the development of ejective consciousness, are least modified by it. External stimuli are still powerful in both of them: the influence of the physical contact of the child in one's arms is evident in those women who, like the lower animals, love their children best while they are very small. But even in sex and parenthood the mental stimuli assert their claim in the case of human beings; the lover persuades himself that his attitude is at least partly due to the mental and moral qualities which his ejective consciousness ascribes to the object of his affections, and the mother supplies herself with a mental stimulus for her instinct by thinking her child a model in intellect and character.

The chief effect upon social behavior of this substitution of internal or mental stimuli in place of external or physical stimuli is to render it *steadier* and *more constant.* This effect is produced in two ways. In the first place, the operation of social instincts is rendered independent of outside conditions, so that a human being may act socially in the absence of the person to whom his action relates. Animals can form only physical crowds, and must as a rule have directly before them the animals they imitate. Human beings, affected by their ejective reading of the contents of other minds, can form crowds with persons far removed from their sight and hearing, and imitate them steadily and consistently whether they are present or absent. The self-exhibiting instinct, originally called forth only in the actual presence of the female or a hostile male, when its stimulus becomes the thought of what other people may think of us, is transformed into a steady, guiding incentive that in persons with highly developed ejective consciousness may be relied upon to keep behavior social even through long periods of solitude. The fighting instinct, when its stimulus is not the presence of the enemy but one's imagination of his thoughts and feelings, gives rise to attitudes of steady and unremitting hostility instead of to sharp and brief conflicts with no "bad blood" left behind. The parental attitude in animals does not long continue after the offspring are removed; in human beings it lasts through years of absence. The faithfulness of an animal to its mate is probably due to the fact that other animals, by reason of their slight physical differences from the mate, fail to supply an adequate physical stimulus for the mating instinct, which has become so modified and specialized that not the generic physical marks of all females, but these *plus* the special marks of a particular female, are its proper stimulus. The faithfulness of a human being to his mate rests on the permanence not of physical traits but of the features of character and mind which he ascribes to her, and may continue long after the physical traits have altered.

In the second place, the operation of social instincts is set free, comparatively speaking, from the dominance of changing physiological states. An animal's instinctive behavior has always two sources, the physical force or stimulus, and the inner condition of the animal. Unless the physiological condition is favorable, as at the mating season, the presence of an individual of the opposite sex fails entirely to call forth the mating reaction. When a certain time has elapsed since the birth of offspring, the protecting attitude of the mother turns to hostility: her physiological cycle has passed on to a new phase. Herrick has pointed out how in birds the instincts of mating, nest building, incubation, and feeding the young follow each other in an order which depends not on the succession of outside stimuli, but on the succession of inner physiological states. In human beings, the freeing of the social emotions and of social behavior from the dominance of physiological states is the greatest practical problem of the emotional life. It is only imperfectly accomplished. We human beings have constantly, in order to avoid wounding the feelings of those we care for or seeming disloyal to the causes we have adopted, the task of feigning in times of unfavorable physiological state the emotions that we feel in full strength only when the physiological state is favorable. But it is precisely because we do thus call to mind the feelings and opinions of others, because we have ejective consciousness, that we are able to feign steadiness and continuity of emotion, and in feigning the emotion, to feel it in some degree at least. And occasionally we meet the truly "spiritual" personality whose enthusiasm for humanity seems always burning with a steady flame unaffected by the rise and fall of physiological states.

It may be said that these effects upon social behavior which we have ascribed to ejective consciousness, to the imagination of what other people are thinking and feeling, can equally well be ascribed to the imagination of other people's behavior; that it is our power to represent in thought what other people will do, rather than our power to represent what they will think or feel, that is responsible for the greater steadiness and continuity in the social behavior of man, as compared with that of the lower animals. I am perfectly willing to admit that the physiological basis of ejective consciousness may be a kind of inner imitation of the behavior of others, but the inevitable accompaniment of such inner imitation is the consciousness of other people's states of mind, and this consciousness may be directly observed by introspection, whereas the movements of inner imitation cannot be directly observed in any complete degree, and have rather to be inferred on theoretical grounds.

Our last question concerns the changes through which ejective consciousness itself passes in the course of its development, both in the race and in the individual. These changes may be summed up under three heads.

First, the evolution of ejective consciousness has involved a continuous broadening of its spatial and temporal reference. The individual or the race with little developed ejective consciousness is capable of interpreting the minds only of those close at hand in space. The person thus limited has little sympathy with persons whom he does not often see; the race thus limited regards all other races as enemy aliens. The undeveloped ejective consciousness is equally limited in its time reference; it cares nothing for history and believes in letting posterity look after itself. Savage peoples and unenlightened individuals sympathize with their contemporaries only.

Secondly, as ejective consciousness evolves it becomes less emotional and more intellectual. Emotions, in our fellow-beings, produce of course more striking physical manifestations than ideas do. When ejective consciousness is but slightly developed, it is still subject to the influence of the external stimulation. The cry of anguish actually heard, the grimaces of the moving picture actor "registering" emotion, bring realization of the state of mind they imply home to minds which would be incapable of grasping the thoughts of another person when those thoughts differed from their own. Moreover, emotional ejective consciousness is more primitive than intellectual ejective consciousness not only because it has stronger physical stimuli, but because there are only a few emotions, and there is an infinite number of ideas.

Thirdly, the development of ejective consciousness has passed from the ability to interpret processes in other minds as like those in our own mind, to the ability to conceive states in other minds as different from those in our own mind. The person of rudimentary ejective consciousness easily conceives that other people feel and think with him: he cannot bring himself to the point of realizing that they sincerely differ from him. We must of course put limits to the power even of the most enlightened in this direction. No one can imagine in another mind a state wholly unlike any that he has ever experienced.

But the person of highly evolved ejective consciousness can, at a given time, set side by side in his mind and contrast his own ideas and those which he realizes exist in the mind of a fellow-being. He can say, "I think and feel thus and so, but my neighbor thinks and sincerely feels in this other quite different manner." For the individual whose ejective consciousness is little developed, if his neighbor's mind is interpreted at all, it is only as an extension of his own mind at that moment.

B[1]

BY C. L. HERRICK

The writer has two horses which for years have been driven, housed and fed together. All habitual activities have been coordinated by necessities growing out of their environment. Originally the animals (mares) regarded each other with distrust and even hostility. Even after years, their intercourse is always aggressive. One steals the other's feed and is attacked for it. There is a continual "nagging." Usually one acquires the ascendency and all that is necessary is a show of teeth on the part of one to cause flight or submission on the part of the other, which, nevertheless, is in a state of constant rebellion.

Now should one animal be left in the stable with a manger full of hay and the other driven away, the stay-at-home is restless and uneasy, declines to eat and neighs continually. The animal driven away strives to turn back, is nervous and neighs and starts out of the road on coming in view of any horse in the distance. Each, as we say, "misses" the other. What is the explanation? Evidently the simplest explanation is that a large segment has been knocked out of self. A whole group of activities (resistances and the like) have been removed. The equilibrium of habitual activity has been disturbed. For weeks every act has been tacitly or by unconscious implication put forth in view of a presence which could be relied upon to react in certain ways. Hitherto the horse never ate, drank or pulled in harness without expecting a certain set of counter actions. These may have been unpleasant reactions. When she drank she expected to be shoved aside, when she pulled she expected to be tweaked by her fellow. But, whatever the character of these acts, they have ceased; to the action the wonted response is wanting.

One gets this sense of hiatus in an elementary form when, in climbing a ladder in the dark, a rung is discovered to be missing. Again, we return to the home after sending the family away on a picnic, thinking "how pleasant it will be to have a quiet day in the study" and find that the unwonted quiet sends us wandering through the empty house seeking we know not what that has gone from our life and the working equilibrium is not soon restored. This is the "feeling of hiatus." It is not confined to animate objects. The writer was once disturbed to find that he could not work well—things were not going as usual—there seemed to be a kind of mental unbalance and he discovered the cause in the fact that he had forgotten to put on collar and tie. This hiatus filled, the typewriter seemed to have as free a play of thought as ever. Certain fussy authors and artists have found it impossible to compose except in full court dress. (I fancy a disembodied spirit would have some difficulty at first with his "hiatus.")

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[1] Taken from "The Beginnings of Social Reaction in Man and Lower Animals," *Journal of Comparative Neurology and Psychology*, XIV (1904), 120–23.

The infant, when passed from the arms of the nurse to those of a stranger, notices the difference and shows fear or discomfort. A strange room also disturbs the equilibrium of experience. The sphere of experience created by every individual is normally a "continuum." When this continuum is disturbed the ensphering environment is left incomplete and one has the same sensation he has when the support beneath him is knocked out. It is not necessary that there should be any intellectual status in the intercourse.

The above seems to be the most elementary condition of social existence. It consists in the enlargement of the sphere of experience by the admission of more and more elements which acquire a value to my being as a part of the equilibrium quite independent of any moral element in it. Its removal produces an emotional reaction growing out of the feeling of loss—hiatus in self—solution of individual continuity. We here have the elementary mechanic of social life.

It is only after this relation is *perceived as mutual* that a moral element enters. When the child was about to leave home for a long visit he visited the cow, the chickens, and the cat to say farewell, and his regret in parting was greatly enhanced by the feeling of how great the grief of these fellow creatures must be in losing him. He even paid a visit to familiar spots and took leave of them with all the feeling of reciprocity that he experienced in the case of living things. These things formed a real part of his experience, he must also form a part of theirs. This feeling of participation is a second step and a moral one. This phase of social feeling is never entirely obsolete. "Who shall smoke my meerschaum pipe" and "these dear spots shall see me no more" illustrate this fact.

Add the further idea of dependence and a high social status is reached. "Really, I ought not to go away, for the servant will forget to feed the animals." Obligation has arisen because of the feeling of participation. I find that I form a necessary segment in their lives, and, as they form a part of my sphere—of "me"—of my larger or social self, I am obligated by that fact, i.e., by an enlargement of the law of self-preservation, to care for these animals. This is an obligation having a different kind and more intimate sort of compelling force than would be possible in the case of an inanimate and so non-participating thing. It may be that in reality the animals do not know that they are dependent on me for their sustenance, but it suffices that I imagine them so to feel. This mutuality feeling makes the obligation moral in a different sense from that growing out of fear that I might perhaps suffer a pecuniary loss by neglect.

It is customary to say that the social self is ejective, i.e., that we project our own feelings and experiences into others and act in view of them. Another and in some respects a truer way of expressing it is that the self is constantly enlarging to embrace new elements. It is not simply that someone else feels as I do—that might be an interesting fact, but it would have no compelling power. It is rather that I affect the other who partakes with me in feeling. My affecting him makes him partner in my feeling. It is the element of participation or recognition of self in others which creates obligation. The mere fact that men in Mars feel as we do would not awaken moral response unless it could be showed that we affected them in some way.

Professor Fiske has indicated that the long period of helplessness on the part of the human infant is a very important factor in the intellectual superiority of the individual human being. Still more important to the race is the effect of long-continued dependence on the development of society. The tie that binds early societies is to a very large extent this same helpless period of infancy. In most lower animals this period being very short, the family relation covers a very limited period, while in the human family under ordinary circumstances this dependence is a continuing state and the family (and so eventually the tribe) becomes a permanent element to be reckoned with in all dealings with men.[1] It is not necessary to point out the many and far-reaching results of this fact.

[1] Note that social insects likewise pass through a helpless stage, requiring active "nursing."

6. COMPLEXES[1]

BY MORTON PRINCE

THE ORGANIZATION OF UNCONSCIOUS COMPLEXES

Everyday life.—It will be well at this point to state in orderly fashion a few general principles governing the organization of complexes or syntheses of ideas[2] which, as we shall see, play an important part in normal and abnormal life. Although this statement will be little more than descriptive of what is common experience it will be helpful in classifying and obtaining a useful perspective of the phenomena with which we shall deal.

Now, as every one knows, the elemental ideas which make up the experience of any given moment tend to become organized (i.e., synthesized and conserved) into a system or complex of ideas, linked with emotions, feelings and other innate dispositions, so that when one of the ideas belonging to the experience comes to mind the experience as a whole is recalled. We may conveniently term such a system when in a state of conservation, an *unconscious complex*[3] *or neurogram, or system of neurograms.* If we wish to use psychological terms we may speak of it as a complex or synthesis of dormant ideas. Although we may formulate this principle as the "association of ideas" the formula can have only a descriptive significance pertaining to a relation in time (and not a causal one) unless there be included an unconscious factor by which the association becomes effective in exciting one idea through another—i.e., through a linking of neutral disposition. We cannot conceive of any conscious relation between ideas that can possibly induce this effect. It must be some *unconscious dynamic relation*[4] and be explained in terms of neural dispositions. If this be so, all ideas are dynamically associated and related in a process which does not appear in consciousness and which is essential for organization into a complex. Every system of associated ideas, therefore, implies conservation through an organized unconscious complex.

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[1] Adapted by permission from *The Unconscious* (2d ed.), pp. 265–71. (Revised.) New York: Macmillan Co. Copyrighted, 1921.

[2] I am using this word in the general sense of any mental experience as in the common phrase, "the association of ideas," and not in the restricted sense of Titchener as the equivalent of a perception.

[3] I use this word "complex" in the general sense in which it is commonly used and not with the specific meaning given to it by the Zurich school, which limits it to a system of ideas to which a strong affective tone is attached and which, because of its personally distressing character, is repressed into the subconscious.

[4] Which may be psychical, although not psychological.

Complexes may be very feebly organized in that the elemental ideas are weakly conserved or weakly associated; in which case when we try to recall the original experience only a part or none of it is recalled.

On the other hand, a complex may be strongly organized and include a large number of details of an experience. This is usually owing to the fact that the original experience was accompanied by strong emotional tones, or by marked interest and attention, or was frequently repeated.

Emotional Complexes.—When the original experience was accompanied by an emotion it may be regarded as having excited one or more of the emotional instincts of anger, fear, disgust, etc. The excitation of the instinct or instincts is in one sense a *reaction* to the ideas of the experience. The instincts then become organized about one or more of the ideas to form a sentiment (Shand) and the whole is incorporated in a complex which then acquires an affective character. The impulsive force of the instinct thereafter largely determines the behavior of the complex. General observation shows that emotional experiences are more likely to be conserved and also voluntarily recalled. Given such an emotional complex nearly anything associated with some detail of the experience may, by the law of association, automatically or involuntarily revive it, or the emotional reaction with a greater or less degree of its associated memories. This tendency seems to be directly proportionate to the intensity of the instinct (fear, anger, etc.) incorporated in the complex. Sometimes, it is true, a strongly emotional experience, even an experience of great moment in an individual's life, is completely forgotten, so completely that no associated idea avails as a stimulus to awaken it. Usually in all such cases the neurograms are isolated, etc., by dissociation. They still, however, may be strongly organized and conserved as an unconscious complex and sometimes may be excited as a subconscious process by an associated stimulus. In such conditions it very frequently is found that the dissociation is due to conflict between the emotion belonging to the complex and another emotional complex. The impulsive force of the latter dissociates the former complex which then cannot be voluntarily reproduced as memory, nor awakened by any association under normal conditions. We have then a condition of amnesia and often an hysterical condition. Passing over these exceptional conditions of conflicting emotions (which being explained "prove the rule"), it still remains true that in everyday life emotional experiences are not only more likely to be conserved but to be subject to voluntary recall, or awakened involuntarily by an associated stimulus.

If, for instance, we have experienced a railroad accident involving exciting incidents, loss of life, etc., the words "railroad," "accident," "death," or a sudden crashing sound, or the sight of blood, or even riding in a railroad train may recall the experience, or at least the prominent features in it. The earlier events and those succeeding the accident may have passed out of all possibility of voluntary recall. To take an instance commonplace enough, but which happens to have come within my recent observation: a fireman, hurrying to a fire, was injured severely by being thrown from a hose-wagon against a telegraph-pole with which the wagon collided. He narrowly escaped death. Although three years have elapsed he still cannot ride on a wagon to a fire without the memory of substantially the whole accident rising in his mind. When he does so he again lives through the accident, including the thoughts just previous to the actual collision when realizing his situation he was overcome with terror, and he again manifests all the organic physical expressions of fear, viz., perspiration, tremor, and muscular weakness. Here is a well organized and fairly limited complex. It is also plainly an imperative memory, that is to say, any stimulus-idea associated with some element in the complex reproduces the experiences as memory whether it is wished or not. Try as hard as he will he cannot prevent its occurrence. The stimulus that excites such involuntary memories may be a spoken word, or it may be a visual perception of the environment—of a person or place—or it may be a repetition of the circumstances attending the original experience, however induced. The phenomenon may also be regarded as an automatism or automatic process. As the biological instinct of fear is incorporated in the complex it is also a *phobia.*

Why our fireman suffered the intense terror that he did at the time of the accident, why he experienced the thoughts which surged into his mind, why he suffered this emotional experience, while another man going through the same accident suffers no more than the physical injury (if any) at the time, and why the experience continues to recur as an imperative memory are problems which we are not considering now. The fact is that he did suffer the terror and its agonizing thoughts, and, this being the case, their constant recurrence, i.e., the reproduction of the experience, is a memory. And this memory consists of a well organized complex of ideas, feelings, and physiological accompaniments. I emphasize this point because an imperatively recurring mental experience of this sort is a psychosis, and, so far as the principle of memory enters into it, so far memory becomes a part of the mechanism of obsessions.

The reason why the man at the moment of the accident experienced the terrorizing thoughts that he did, and why he continued to experience them, must be sought in associated conserved experiences of his past. These experiences were the psychogenetic factors. It would take us too far out of the way to consider this problem, which belongs to the obsessions, at this time, but, as I have touched upon it, I may say in passing that the accident would have awakened no sense of terror and no emotional shock if a *psychological torch* had not already been prepared. This torch was made up of ideas previously imbibed from the social environment and made ready to be set aflame by the match set to it by the accident. In the unconsciousness of this man were written in neurographic records the dangers attending accidents of this kind and dangers which still threatened his present and future.

Likewise the *insistence* of the memory can be related to a setting of associated thoughts which gave meaning to his perception of himself as one affected, as he believed, with a serious injury threatening his future. His fear was also, therefore, a fear of the present and future. Thus not only the experiences of the accident itself became organized into a group and conserved as a memory, but were organized with memories of still other experiences which stood in a genetic relation to them. If it were necessary I could give from my personal observation numerous examples of this mode of organization of complexes through emotional experiences and of their reproduction as automatic memories.

EXERCISE

1. What are some of the complexes frequently manifested by college students? How do you account for their development and close organization?

7. DISSOCIATION[1]

BY BERNARD HART

If we are asked to turn our mental eye inwards and carefully observe at any given moment the content of our mind—or, as it is technically termed, the momentary "field of consciousness"—we should probably describe it as an indivisible whole, a uniform stream of thought progressing towards some definite end. It would not appear to be composed of separate parts, each proceeding independently of the other, but of sensations, ideas, and volitions all united in some common aim. If I am engaged upon a mathematical problem, then my field of consciousness seems to consist at the moment solely of the various mental processes necessary to the solution of the problem. A few moments later my attention may perhaps be diverted to making plans for a forthcoming holiday, but the mathematical problem will then have temporarily retired from the field of consciousness; the problem and the holiday plans do not both occupy the mind at once, although our attention may rapidly oscillate from one to the other. We should find, moreover, that in spite of the fact that mathematics and holidays have apparently nothing in common, there was nevertheless some link which carried my mind over the gap between them, and that in reality no break in the continuity of the stream of thought occurred.

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[1] Adapted from *The Psychology of Insanity*, pp. 40–52. Cambridge: University Press, 1916.

Yet this statement is only partially true of the normal mind, and it is hardly true at all in the case of some of our patients. Their minds are frequently very far from being uniform streams of thought progressing towards some definite end, but are on the contrary composed of more or less isolated mental processes, each pursuing its own development. This division of the mind into independent fragments, which are not co-ordinated together to attain some common end, is termed "Dissociation of Consciousness." A few examples of various degrees of dissociation will make our meaning clear.

It has been pointed out that even the normal mind does not always present that undivided field of consciousness which we might be tempted at first sight to ascribe to it. Suppose, for example, I sit at the piano and play a piece of music. If I am a sufficiently expert performer it is possible that I may at the same time be able to carry on a complex train of independent thought, let us say the solution of some problem of conduct. My mind does not under these circumstances present a uniform field of consciousness, but one divided into two parts or processes. Each of these processes requires a considerable expenditure of mental energy. The piece of music is perhaps one which I have never seen before, and it has to be played with appropriate and constantly varying expression—while the problem of conduct may be similarly complicated in its character. Each of these activities is almost entirely independent of the other, yet both can be carried on at the same moment. The field of consciousness must therefore be divided into two portions, in other words a certain degree of dissociation of consciousness must be present. Similar remarks apply to many other simultaneous activities; for example, those exhibited by the skilled tradesman who plies his craft while his mind is at the same time occupied with other matters.

In all these cases, however, the dissociation of consciousness is temporary, and only partial in character. Both activities are under the control of the subject, and either may be abandoned at will. In the more marked degrees of dissociation found in our patients this control no longer exists.

Let us take, for example, the phenomenon of "automatic writing." This curious condition, although occasionally exhibited by comparatively normal people, attains its most perfect development in the form of mental disorder known as hysteria. Suppose that we engage an hysterical patient in conversation and, while his attention is thus diverted, insert a pencil between the fingers of his right hand If a third person now whispers some question into the patient's ear it may be possible to induce him to write answers to those questions although he continues all the time to discuss with us some totally different subject. Under such circumstances it will be found that the patient is entirely unconscious of what his hand is doing, and is, moreover, often altogether ignorant of the events which the writing describes. These events frequently relate to episodes in the patient's past life which he appears to have completely forgotten, and the experiment is occasionally employed with the object of resuscitating such buried memories. It may be remarked that this loss of memory for some definite section of the patient's past experience, often extending over a considerable period of time and including events of great importance, is a characteristic symptom of hysteria.

Automatic writing has played a large part in the history of spiritualism, and has been attributed by supporters of that doctrine to the activity of some spiritual being who avails himself of the patient's hand in order to manifest to the world his desires and opinions. There is no need, however, to resort to fantastic hypotheses of this type, and the explanation of the phenomenon is comparatively simple. A dissociation has taken place, though one far more complete than those hitherto described. The field of consciousness is divided into two distinct parts, one engaged in conversation, the other comprising the systems of ideas which are finding expression in the automatic writing

Each portion carries on complicated mental processes, and yet each is not only independent of the other, but totally unaware of that other's existence. The patient's mind seems, in fact, to be split into two smaller minds, engaged in two different occupations, making use of two distinct sets of memories, and without any relation whatever one to the other. Such a case, therefore, provides us with a most perfect example of dissociation of consciousness. But it must always be remembered that, however strange and incomprehensible such advanced dissociations may at first sight seem to be, yet they are nothing but exaggerated forms of those dissociations which have been seen to occur in every normal individual.

Let us now proceed to the consideration of a type of dissociation only slightly different from that just described. We found that in the uniform stream of thought characteristic of the normal mind there was no break or gap in the continuity of ideas. However abruptly a new idea might arise in consciousness, yet it was always possible to demonstrate that the apparent gap was really bridged by some associative link. The consciousness of any given moment, moreover, was always perfectly aware of the mental processes which had taken place in the consciousness of the preceding moment. Now it is possible to imagine that this continuity in the stream of consciousness should suddenly cease to exist, that the stream should be, as it were, suddenly broken across. The content of consciousness immediately after the break would then be absolutely independent of the content of consciousness in the moment preceding the break. All the relations between the two would be severed, and the consciousness of the second moment would therefore be entirely unaware of what had been contained in the consciousness of the first moment. The mind of the individual would, in fact, suddenly be filled with a new series of ideas, while it would at the same time be altogether ignorant of the ideas which had occupied it a moment previously. We have here, not a dissociation of consciousness into two separate simultaneously present portions, but a dissociation of the consciousness of one moment from the consciousness which preceded it. This is the type of dissociation which occurs in somnambulism. In such a case the continuity of transition observed in the normal mind has been replaced by an abrupt change from one train of ideas to another train which has no relation to the first. If we compare the field of consciousness to a cinematograph screen, then the normal process corresponds to the continuous change in the picture produced by a single film, while the dissociated processes occurring in somnambulism correspond to the effect obtained by abruptly breaking off one film, and replacing it by another representing an altogether different subject. The type of dissociation seen in automatic writing, on the other hand, would be produced by employing two films at the same moment, each projecting its picture upon a separate portion of the same screen.

The dissociated system of ideas whose eruption into the field of consciousness is responsible for the appearance of a somnambulism, may attain to any degree of complexity and development. In some cases, however, the dissociated system is far more extensive and more completely developed, including within itself whole tracts of the patient's mental life. Under these circumstances the patient's behaviour may be comparatively normal, and adapted to the environment, even when the dissociated system is in entire possession of the field. Such cases are not generally termed somnambulisms, although they are precisely similar to the latter in their fundamental characters, but are regarded as examples of "Double Personality."

Double personality is a phenomenon which has aroused considerable popular interest, owing, no doubt, to the dramatic character of its manifestations. It has furnished fascinating material for works of fiction, headed by the famous "Dr. Jekyll and Mr. Hyde" of R. L. Stevenson. A large number of actual cases, however, have now been described, and in its less perfect forms double personality is by no means so rare as is generally supposed.

All the examples of dissociation so far given show us systems of ideas, or trains of thought, which are split off from the rest of consciousness, and which lead an independent existence. In both automatic writing and somnambulism two well-marked characters are present. Firstly, the main body of consciousness—or, as it is usually termed, the personality or *ego*—has no knowledge of the dissociated system. Secondly, the dissociated system develops autonomously, that is to say it pursues its own course without any dependence upon the main body of consciousness. It is, in fact, altogether exempt from the control of the personality.

8. TWO CASES OF DISSOCIATION

A. Patience Worth[1]

BY CHARLES E. CORY

In describing the case it will make for clearness if the reader will understand that Patience Worth, the writer, is a subconscious personality of Mrs. John Curran, of St. Louis. About five years ago Mrs.

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[1] Taken from "Patience Worth," *Psychological Review*, XXVI (1919), 397–406.

Curran began to write, automatically, literature of an unusual character. Since that time novels, plays, and poems have appeared. Over fifteen hundred poems have been written. Two of the novels, "The Sorry Tale" and "Hope Trueblood," have been published by Henry Holt & Co. Four additional novels are in various stages of completion. Most of this literature is conceded by critics to be of a very high order. No two of the larger works are written in the same English. They range from a very old English to one that is in nearly all respects modern. *The New York Sun* said of "Hope Trueblood": "It is a story that George Eliot might not have been ashamed to own up to." Of the "Sorry Tale," *The New York Times*, in reviewing it, said: "The long intimate tale is constructed with the precision and accuracy of a master hand. It is a wonderful, a beautiful, and a noble book." And from the *Boston Transcript's* review of the same book I quote: "The thoughtful reader will marvel at its beauty, its poetry, its power. The impression is that it is the work of a literary artist." Mr. Reedy, the editor of *The Mirror*, and a distinguished critic, says of it: "This is the most remarkable piece of literature I have ever read. I have no hesitation in saying that this production (I ignore any religious claim for it, and I discount that adventitious interest in the manner of its appearance) is a world literary marvel."

Mrs. Curran is a woman thirty-five years of age. Her education did not extend beyond the grammar school. Her general reading has been meager and desultory. She has not been abroad, and has traveled but little in America. She has no experience or practice in writing, and never entertained any aspiration to authorship. The one ambition of her life has been to sing. She has a good voice, and until Patience Worth "arrived," her entire energy was given to its cultivation. No one could be more surprised and mystified by what has taken place than Mrs. Curran. It should not be inferred that Mrs. Curran is an unintelligent woman. On the contrary, she is very intelligent. Her quick intuitive understanding is recognized by all who know her well. A conversation with her, however, though based upon an extended acquaintance, does not give the impression that one is in the presence of the mind that wrote "The Sorry Tale." And so foreign to her entire life do Patience Worth and her writings seem, that both she and Mr. Curran have, from the beginning, looked upon her as a disembodied spirit. Toward her they hold an attitude of awe and reverence.

Before writing, Mrs. Curran appears to have no intimation of what is coming. She shares with those present complete ignorance on this point. It may be one of several novels, poetry, or general discourse. Without delay the writing proceeds, and with a speed that frequently outstrips that of the most expert longhand writer. In the most difficult part of a novel she has written as high as five thousand words in an evening. The composition is final. A complete record has been kept of all that has been written. These records, running back to the first manifestations, afford a good outer history of the case. Aside from the literary output, the discussions and conversations fill many volumes.

A thing that gives special interest to this literature is that most of it reflects the life and manners of other times, and this it does with an intimacy that astonished the reader. They presuppose upon the part of the author, a wealth of information, a richness of contact that is normally secured only through a prolonged study. "The Sorry Tale" is a large and intricately woven novel dealing with Jewish and Roman life at the beginning of our era, involving an enormous mass of knowledge of the life and customs of that time. It is a powerful drama, full of subtle humor and seasoned wisdom. "Telka," an unpublished poem of seventy thousand words, has an English background. The language used is unlike that of her other works. It is in archaic English of different periods, and various localities. It is difficult to understand how it could be used as a medium of poetry by a modern writer. And the source of this language is a part of the general problem. "Hope Trueblood" has an English setting of the early mid-nineteenth century. "The Merry Tale" goes back to the days of the cross-bow. It is a humorous tale of rough tavern life. The language is not modern, and the general reader would find it difficult. Only a reading of the million and a half words that have been written can give an adequate idea of the great reservoir of knowledge that is accessible to this secondary personality. A careful survey of Mrs. Curran's reading from childhood leaves the problem of its source largely unsolved. What she may have heard, or rather, what may have been said in her presence, is another matter, and, obviously, a far more difficult thing to determine. But a knowledge of the interests that have dominated her life forces the conclusion that most of this material did not pass into her mind through the channel of her conscious attention. What her total environment has been, and just how that environment has been appropriated, is the question. And the problem is complicated by the fact that there have been two selves, that is, two centers of apperception drawing upon that environment. Hence no history of Mrs. Curran in terms of an ordinary biography could hope to solve the problem. Not one, but two histories must be traced. So far only one has been followed. And its value, in view of the probability that the dissociation is of long standing, is, and could be, only indirect. It only defines the problem, marking off the residue to be explained by processes which did not enter her consciousness. And there is in the material thus left, much that is significant for the study of subconscious perception and memory.

But even more significant, it seems to me, is the bearing which the case has upon the problem of subconscious reflection processes, or those that are commonly so called. It offers a new answer to the question that is of growing interest, namely: What degree of rationality may the processes of a subconscious center attain? Here there is a product showing a mentality of a very high order. It is original, creative, possessing a delicate sense of beauty, a hardy rationality, and, above all, and perhaps most surprising, a moral and spiritual elevation. Patience Worth easily meets most tests that are applied to the normal personal consciousness. In conversation she displays a quickness of insight, a readiness of repartee that enables her to hold her own in the company of the learned. Mrs. Curran is an intelligent woman, but her mind is much inferior to that of Patience Worth. In short, here is a subconscious self far outstripping in power and range the primary consciousness. This is an indisputable fact, and it is a significant one for psychology. In some way the dissociation has resulted in the formation of a self with greatly increased caliber. It has not only given it access to a much wider range of material, but it has given it a facile creative power amounting to genius. It is hard to give an adequate impression of the versatility of this mind. Intricate composition proceeds with astonishing ease. During an evening she may write alternately upon several novels, passing from one to the other without a moment's pause. And this work is accomplished without the aid of manuscripts. While writing Mrs. Curran does not have before her the finished portions of these works. A novel untouched for weeks or months will be resumed at just the point where it was broken off.

When writing, Mrs. Curran goes into no trance. In other words, the primary self is not displaced, or it would be more accurate to say that the modification that occurs does not amount to an alternation of personality. To the casual observer no change is noted. There is, however, some abstraction. This is more pronounced than it was formerly. When the writing began, it was read from the board; an ouija is used, in the usual manner. But years of practice have made it possible to write with only an occasional reference to the printed letters. A general movement of the hand is now sufficient to throw the letters into the consciousness of Mrs. Curran, and these are rapidly spoken as they appear. Not only do the letters appear but the entire panorama of the story seems to move before her, like pictures on a screen. Within the field of the primary consciousness there is a smaller field, and within this field the characters of the novels act their rôles and are seen as vividly as on a stage. Apparently the only effort required on the part of Mrs. Curran is that involved in passivity. With the proper abstraction she receives from the secondary self the letters and imagery. The meaning of what is written is, naturally enough, frequently not understood by her. Neither its form nor its substance is determined by her consciousness. They are apparently the creation of a self whose existence she is, for the most part, completely unaware of. And this self is no mere by-product of a more fully developed mind. Patience Worth is a personality of tremendous creative energy. And unlike most dissociated personalities she is morally sound.

Is there not here, then, material for a new answer as to what a subconscious mind is capable of doing? But one may ask, is this mind really submerged when it does this creative work? In other words, may it not all be done at the time of writing when Mrs. Curran's abstraction permits a slight emergence above the threshold? And is not this approach to the surface a condition of lucidity? A brief study of the case will eliminate that possibility. It is true that some of the poems are thought out as they are written, that is, they are improvised at the time of writing. And the actual composition of the larger works probably receives at that time its final form. But it is inconceivable that these elaborate and intricately wrought novels should not have been planned before they are so hastily written. And that they are the work of previous thought is confirmed by Patience Worth's own statement. This means that while Mrs. Curran goes about the cares of her household, the other self, unknown to her, may be deep in an English novel. The selves, to repeat, are not alternating but coexistent or co-conscious. Such co-conscious phenomena are now familiar enough to psychology. That which is peculiar to this case is the quality of the mentality of the secondary self. The passage from the primary to the secondary self is not one into a twilight zone or semi-darkness. On the contrary, there is met a mind of a higher order, a mind of decidedly greater power. And of the activity of this self, aside from the slight contact while writing, Mrs. Curran has no knowledge. There is evidence, however, that the secondary consciousness includes much, or possibly all, of the field of the primary consciousness. That is, while Mrs. Curran has no knowledge of Patience Worth, the latter is probably aware, in a way, of all that the former experiences, or may at any time become so.

It is evident that the term subconscious is misleading when used to describe the source of this literature. As generally used it would imply that these works are the product of marginal or submarginal tendencies. This they are, only with reference to the other field. With reference to the self that created them, they are distinctly within the conscious. The term co-conscious, as used by Prince to describe somewhat similar cases, is helpful here. At all events, and this is the significant thing, these delicate and finely rational processes, these highly elaborate compositions, are performed apparently without the aid or knowledge of Mrs. Curran. Just how these works are composed, and just what the sources for much of the material are, this report has little that is definite to give. It is chiefly interested in attesting to the above facts.

Some reflections, however, have occurred to me in reviewing the case. I accept the judgment that Patience Worth is a genius of no mean order. And, perhaps, there is in the genius of this writer a concrete illustration of what freedom a mind may achieve when released from the inhibitions that clog and check the normal consciousness. She is a dissociated self, and this dissociation has taken place in such a way as to free her from the burdens and concerns of life, from all the claims that split the will and bind the fancy. And perhaps in this fact, and all that it implies, lies the condition of her genius. The division of the self has resulted in a division of labor. To Mrs. Curran falls the care of the needs of the body, and the interests of the social life. Their reactions and distractions are hers. From all this Patience Worth is free. Between her and the entire active phase of life stands the buffer consciousness of Mrs. Curran. In aloofness and abstraction she dwells. She is beyond the reach of perturbation and confusion, and therein lies her strength. Her mind seems to possess the effortless activity, and facility of a dream, a dream without chaos. The normal consciousness is forced constantly to divide its attention between the world of idea and the world of action. The imminence of action is never far removed. Consequently its moments of abstraction or thought are brief and fitful, sustained with effort against the solicitation and lure of sense. The organism requires constant orientation. This holds the attention and divides the energy. It is well that the imagination, in normal life, is weighted and somewhat inert. Action and its world have their claims, and these are, as they should be, strong. But unless they are to some degree inhibited they tend to absorb consciousness. Fancy is crowded out or sustained with effort. Irrelevant it perishes.

But turn to this dissociated mind and the conditions have changed. The work of adjusting the organism to the environment being left to the other self, the inhibitions which perception places upon the imagination are removed. This sets free and unfettered the mind of Patience Worth. In the realm of the idea she lives, and there she sustains herself without effort. She acknowledges no tie or bond that might take her out of her dream. She is a dreamer that never awakens. And the conditions of this spell are, in a way, the condition of her genius. With her our moments of abstraction, moments that life affords us the luxury of thought and imagination, are prolonged indefinitely. They are, in fact, a fixed condition. In other words, she lives only in a world of thought. And so far she has shown no desire to displace the other self, and alternate with her in the rôle of action. To do so would result in essential modification of her consciousness, and put her under inhibitions from which she is now free.

It is clear that we are here dealing with a mind so constructed as to open up most interesting possibilities. Structurally, the type is so novel that it is hard to imagine either its range or its limitations. Its actual behavior is instructive from every angle, whether it be from that of memory, feeling or thought. In regard to all of these, interesting modifications of normal experience are observable. It is difficult to give an adequate impression of her composition, its ease and rapidity, and no less impressive are her feats of memory, such as reproducing immediately, upon request, an early chapter of "The Sorry Tale" which had been mislaid, months having elapsed since the time of its writing.

A reference has been made to dreams. While surely very unlike dreams in most respects, there are, I believe, some points of resemblance. Some things are done that would suggest that in a mind of this type the processes have a tempo not normal, probably much accelerated. And since, as in dreams, this mind is not correlated with action its tempo may resemble more that of dreams than that of normal life. Something like this I know to be definitely affirmed in a case of alternating personalities, that is, one of the selves insists that upon taking control or possession of the body she experiences a noticeable restriction and loss of freedom in her thought. The structural changes involved in such forms of dissociation would provide the explanation for these accounts, should they prove to be statements of fact.

The point in question is one upon which all available data should be brought to bear. The idea would admit significant alterations of normal experience. Processes of mediation, normally requiring considerable time, might approximate immediacy, as seems to be the case in certain dreams, when a highly complex experience presents within itself directly its meaning. Some of the performances of Patience Worth would suggest that she may have some advantage over the normal consciousness in this regard. Such a supposition would also throw some light on her power of orientation, as illustrated in her shifting without pause from one novel to another. In doing this she changes periods of history, and passes at once into another world of feeling and action, and clothes it in a different style and language. As in dreams the appropriate mood and background follows quickly any idea, unchecked by the stability of outward circumstances. Within the mind itself, however, all seems under a nice control.

I have spoken of the rationality and sanity of this strange author. This is the impression of hundreds that have talked to her. And I believe there are few writers that get nearer to the heart of human life. But one need not concede that she is a great genius in order to see the problems involved, and their interest to psychology. I have briefly sketched what they appear to me to be. At another time I hope to make more detailed statement of the case.

One more thing should be mentioned. The assertion was just made that Patience Worth was highly rational, sane. Upon one subject, however, this mind is under an illusion. It is well known that she insists that she is the discarnate spirit of an English woman who lived in an age now long since passed. She not only insists upon it but she argues her claim at length, and with cleverness. And, to my mind, it is doubtful whether the S. P. R. has on hand better "evidence." That she is honest in this belief there is no reason to doubt. The full history of this illusion, this idea that she is a returned spirit, can be secured only by psycho-analysis. But it is worth noting that Patience Worth made her appearance after Mrs. Curran had spent many evenings with a friend, a confirmed spiritualist, with a view of getting a message from the spirit world. In the atmosphere of expectancy, of hope that a voice from the dead might be heard, she may be said to have been born, and it is more than possible that the idea became, at that time, a vital part of the dissociate self then developing. Thus in this self is found just that idea that would sever it most completely from the dominant personality of Mrs. Curran. This idea, although having, I believe, nothing to do with the real cause of the disintegration, has helped shape and mould her character. What is more she has lived in the atmosphere of the idea ever since the day of her appearance, those about her acting their part in sustaining the illusion. This chapter of the story is too large for this context, but it is an interesting one.

B. A Divided Self[1]

BY CHARLES E. CORY

A is a woman twenty-nine years of age, the fifth of a family of six children, all living. The father was fifty-six at the time of his death. The mother is still living. The mother's side is negative. The father, an habitual drinker, committed suicide. One brother has reputed "psychic powers." A, while not robust, has no organic trouble. As a child she was very emotional, high tempered, and much older in manner than her years. She has never had any serious illness. Her height is five feet, and she weighs eighty-one pounds. This is seventeen pounds under her maximum weight. At present she is a saleswoman, and is considered a good one.

B's appearance as an alternating self began about three years ago. The change was, at first, accompanied by brief trauma. This has now disappeared, and the change is generally made without disturbance. The transformation produces a marked change in the face and bearing. Respiration is deeper, and goes from eighteen to twenty. The body is slightly flushed, and the eyes are brighter. The expression of the whole face is altered. Her manner is vivacious and aggressive. The timidity of A is replaced by the utmost confidence and self-assurance. Although A may have been fatigued no trace of it will be seen in B. Indeed I have never known B to show any signs of weariness. After A has come home utterly exhausted, too tired to eat, B has come, eaten a hearty dinner, and enjoyed the evening. This new influx of strength is, in itself, a nice study, and affords further evidence of James' and Sidis' doctrine of various levels of energy.

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[1] Taken from "A Divided Self," *Journal of Abnormal Psychology*, XIV (1919), 281–85.

The cause of the dissociation was, undoubtedly, a shock which A received from the tragic death of her father. A loss of co-ordination followed this event, and for a while she was hardly able to walk. It was, as she says, "Like learning to walk again." At this time hallucinations began to appear. Further, according to B's statement, it was at this time that she secured partial control of the body. The behavior of A, from that time, shows noticeable signs of instability. She was subject to moods of extreme vanity, and occasional bits of conduct which were to her, at the time, inexplicable, such as, without intention, getting out of bed and going through weird dances. Many things occurred during the years that followed that now clearly show that a well-organized subconscious complex was formed, and that, at the time, it exerted a dominating influence. It was not, however, until A was twenty-six that she learned of B's existence, and then what little she knew was shrouded in mystery. I give A's own account of the incident. "One evening while alone in the house I was seated at the piano, and it seemed like something said to me, 'take a deep breath,' and a sound of singing came from me that I had never heard before, and it frightened me. Just before the song I shuddered as if something had possession of me, I went to the kitchen to get a drink then, and I asked mentally who that was that sang, and I got the name——". It was several weeks, however, before B learned, to use her expression, "to get completely out," or to submerge A, and take full possession of the body. Since that time they live as alternating selves. If A is abstracted B may appear. Generally A's consent is required, but sometimes B will catch her off her guard and be "out" before she knows it. Much as she desires to come she has a dread of meeting awkward situations, and as a result of this fear she leads a very restricted life. In the immediate household A's mother is the only one that has seen her. For a year A was completely mystified by the strange appearance. B had announced herself as the reincarnation of the soul of a Spanish woman, and this claim, was in a way, accepted by A. After hearing a voice that was not her own, and singing in a tongue that, as we shall see more fully later, she could not understand, what else was there for her to believe? Thus neither A nor B thought of themselves except as completely separate personalities, A assuming that B on occasions took possession of her body. In this she was confirmed by some spiritualistic friends who became greatly interested in her. B's own idea of herself, that is her belief that she was a returned spirit, was also, of course, encouraged by this atmosphere. Over this coterie of believers B exerted a tyrannical influence and in every whim she was indulged.

Each, if interested, is conscious of, and remembers what the other does. When subconscious A plays the rôle of an onlooker, but is powerless to determine B's conduct. Frequently conversations are carried on between them. In this case an inner voice expresses the thought of the self that, at the time, happens to be subconscious. B when subconscious may, if she chooses, profoundly influence A, whereas A as subconscious leaves B comparatively free.

A is a bright cultivated woman, of a good family, and when young had all the advantages that money could give her. B is older in manner, more dignified and serious. She has read Sally Beauchamp, Prince's Volume on the Unconscious, and several works in the field of abnormal psychology. These she reads with ease and understanding. She also expresses herself with great clearness. She is acquainted with my own analysis of her case, and has helped in every way she could. Yet notwithstanding her ability to follow a psychological analysis, after a full statement of the case she retains unmodified her conviction that she is a reincarnated spirit, and that she lived and died long ago. What seem to her to be memories impose themselves upon her, and prevent her from *feeling* that any other explanation can be true. A, however, now understands enough of the case to know that B is a dissociated self, and much of her past life, hitherto strange to her, has become clear.

One of the interesting things about this case is B's speech. Her English has a marked foreign accent, and has had from the first. The accent is Spanish. Now at no time in her life has A studied a foreign language, nor has she ever been intimately associated with Spanish-speaking people. Not only does B's English have an accent, but at times she speaks automatically in a "tongue" that is made up entirely of fragments of Spanish, with traces, possibly, of Italian. She also writes it automatically. When spoken it is generally accompanied with imagery and strong emotion. B was amazed when she first learned that she could not translate it into English. I here give a sample of this "speech." It was written automatically.

"El spir desempenarsa Maria Rozell Rosa si exusadosa los almos los limasa los immundosa Palaisa Rayals Madrid Espana ple none dusa duer Reyos Ferdinando III si del hombri carcela mito De Grandoza espio del Reyos Ferdinando III los padre houerta el santa virginus bella almos fuami del pico si questa monos si cruir y los mendato spirato del prego duosa fuar cristes felami Reynos Carlos Naples Italy Carnaval des bella in carles aquellas Romitas Ferdinando III. castilliuanos reyos immortalidade almos del maria Rosa los spiranosa del uberia costa quelle di si amicos zeus romania alesticad pon che nome fluer yoso dente quami."

The source of this "tongue" has so far not been definitely determined. Repeated hypnosis of A and B fails to reveal anything conclusive. At a Catholic school which A attended when a girl there were three pupils from Mexico who spoke Spanish. A says they were not friends of hers and that she did not associate with them, but that she can remember she was thrown with them when taking lessons, and that during these hours these girls sometimes conversed among themselves in Spanish. This would have afforded an opportunity for A to have unconsciously assimilated their speech. And it may be possible that it is this, that twelve years later, appears in garbled form in B's automatic speech. This, to some extent, is confirmed by the fact that when B was put under hypnosis and taken back to the convent days she began using the "tongue." But as it is apt to be used in certain levels of hypnosis, it is difficult to say whether the convent association has any necessary relation to the speech. It would, however, tend to prove that its source belongs to the period of the years at the convent, that is, it is found in that stratum of the subconscious. It is true that this period antedates the shock. A's convent life ended with the death of her father. However the history of A's childhood shows, I believe, that a condition of nervous instability was then present, and that the shock merely sundered associations that were already only loosely organized. But the difficulty with the above hypothesis as to the source of the Spanish "tongue" is that B's whole character has been molded by the Spanish idea. She is in all of her tastes and preferences foreign. The idea that she is Spanish saturates her. She is even fond of dishes that are, or that she images to be, Spanish, and no dark complexion escapes her. And this idea embedded in B as a subconscious or co-conscious complex has resulted in her absorbing an enormous mass of stuff more or less Spanish in character. Most of it A, of course, is unconscious of ever having heard or seen. Like a magnet subconscious perception has picked up everything that is congenial to it. Out of this mass, after due incubation, has evolved the strange fabrications which when they enter B's consciousness impose themselves upon her as memories, and when they appear they are heavily charged with feeling.

Now for this deep-seated desire for things Spanish more than a casual motive must have been at work. Nothing, so far, of an adequate nature has been found in the convent period. It is this fact that leaves that hypothesis incomplete, if not false. Shortly after the shock, however, something that might have supplied the interest occurred. In fact when the psychology of B is considered no motive could be stronger than the one that then arose. It was then that A made the acquaintance of Mr. X, a man many years her senior, and for whom for some time there existed a strange fascination. Mr. X was a man strongly Spanish in appearance, and his mother was a Spanish woman. This friendship is now clearly recognized by A to have been B's affair, and this B admits, and generously exonerates A from all blame. That is, B, at the time existing only subconsciously, so dominated the behavior of A, in this instance, that the affair really belongs to her. As this was the period of B's growing dissociation the influence of Mr. X upon her character can probably not be exaggerated. It could scarcely have been otherwise. In many subtle and profound ways she was shaped by it, and of this there is ample proof. And it may be that as means of explaining this bond of affinity the idea occurred to B that she must be of Spanish blood. Once rooted the idea would shape all in conformity to it. What adds weight to this possibility is the fact that the sex impulse was a central factor in the dissociation. There was a strong tension here, and when the shock came it formed the line of cleavage. Once removed the sex complex became the dominant one in the new group. Thus freed it acquired new strength. In B its influence is persistent and pervasive. She now imagines that when she lived before she was a large and powerful woman, whose passionate nature played havoc with many a lover. For the frail body of A she has nothing but contempt. She cannot get adjusted to A's fragile organism, her imaginary one is far more real to her. In hypnosis this fancy of B's becomes an hallucination, and she sees herself possessed of all the feminine charms. In A's body she says she "feels like a lion in a bird-cage."

EXERCISE

1. Each of us in a way has several selves—that of the classroom, that of the club, that of the family circle, that of his day-dreams. What are the main distinctions between the ordinary multiplicity of selves in one individual and that demonstrated in the foregoing account?

9. THE CAUSES OF MULTIPLE PERSONALITY[1]

BY CHARLES E. CORY

In cases of dissociation vital constellations may be observed to form within the frame or scope of the mind's abstract or general ideas. A latent complex emerges, becomes active, and a new determination is given to the formal cognitive background. Something has happened that lights up and vitalizes certain aspects of the abstract whole. Something has reached out and touched certain possibilities and they have become living tissue in a vital organization, whereas before they lay, pale and impotent. What is it that has quickened them into life, that has drawn them out from their impotent and empty generality? The intellect is powerless to give definite content to its own abstractions. Any experience as construed by it includes the possibility of an indefinite number of selves. Being without preference it has no disposition to realize any particular possibility. Its neutrality holds it to bare generality.

It would appear, therefore, that the intellect, as such, cannot provide a clue to this strange alternating of selves. The dislocating factor must be sought elsewhere. In fact no organization of experience is ever the result of reason alone. That the contrary could have been assumed is due to the fact that in making a synthesis reason is prone to hold that it is the result of an objective necessity. Reason may provide possibilities but their organization awaits upon the adoption of a given end. It is the end that determines how experience shall be organized. It is the end that reaches out and calls into life what is implied in its realization. That which does not enlist in the service of the recognized end is without power to make its claims felt.

In observing the transition from one self to another (I have in mind cases of dual or multiple personality) one is conscious of a shift of ends or system of ends. In addressing the new self you are confronted by a new set of presuppositions, at the heart of which will be found, as their generating cause, a new group of impulses or desires. These impulses engender an atmosphere of feeling that warms and illumines the world in their own peculiar way. They light up and warm into life what is congenial to them. About them is built up such a constellation of elements as is implied in their realization. Withdraw them, as they are withdrawn when the self is displaced by another, and the constellation disintegrates and disappears. What was plausible now seems unreal. If pressed its validity may be conceded but since it leads the way to no desire the will is left cold.

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[1] Taken from "The Problem of the Individual," *Journal of Abnormal Psychology and Social Psychology*, XVI (1921–22), 377–78.

All of this may be said, also, of the normal individual. Formal admission followed by actual repudiation is common enough. In the behavior of a dissociated group or personality, however, it is an outstanding characteristic. It is so obvious that it cannot fail to be instructive. It brings unmistakably into the foreground the fact that it is some community of feeling that, in the last analysis, determines what associations are formed and how stable they will be. Some form of sympathy binds particular processes together, and some common bond of feeling is the condition of any wholeness or unity in a given experience. In some community of purpose, therefore, we shall probably find the principle that determines what is individual.

The study of the causes of dissociation tends, I believe, to confirm the above statement. Always there is found some deep-seated emotional conflict. Tendencies that are apparently irreconcilable press their claims. In this conflict each elicits all the associations that are congenial to it. If the nervous system has a high degree of stability the strain may be borne. As with the British political life strong conflicts occur but they do not disrupt it. A common tradition weathers the shock. But if an instability exists the strain, in time, undermines the integrative forces. The way out is the way that life, in its evolution, so often takes when incompatible tendencies appear together. A bifurcation, or division takes place. This reduces the tension, as when two occupants of a room finding themselves hopelessly incompatible agree to occupy it alternately.

Now these alternating selves are incompatible for the same reason that individuals may be socially or conjugally incompatible, and that is that their emotional life is discordant. Difference in thought as such does not arouse antagonism. It is contrary currents of feeling that produce friction, some divergence of impulse and instinct. And this is true of relations between individuals and between processes that fall nominally within one.

10. HYPNOSIS[1]

BY CHARLES H. JUDD

Hypnosis a form of dissociation closely allied to sleep.—The condition known as hypnosis has long been the source of superstitious wonder, and much has been said and written in regard to it which would tend to increase the mystery which attaches to it. In many respects it is a condition closely related to normal sleep. On the other hand, it has certain peculiar characteristics which differentiate it from ordinary sleep.

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[1] Adapted from *Psychology*, pp. 287-91. (Revised edition.) Boston: Ginn & Co., 1917.

Methods of inducing hypnosis.—The way in which the condition of partial or hypnotic dissociation is produced in the nervous system differs with the practice of different hypnotizers. One of the characteristic methods of producing hypnosis is to require the subject to gaze at some bright object until a kind of partial stupor comes over him. He may then be aroused to activity through the sense of hearing. The ideas which he receives and the activities which he performs have, under these conditions, many of the characteristics of dissociation. Another way of producing hypnosis is to soothe the subject into a sleeplike condition. Stroking the forehead or the face is very commonly practiced by hypnotizers. Here again, the appeal to the subject, after the dormant condition has set in, is through the sense of hearing or even through the sense of vision.

Hypnosis more readily induced after it has once been established in a subject.—When a subject has been frequently hypnotized, it is possible to reproduce the hypnotic condition without elaborate preliminaries. The subject acquires what may be called a habit of dissociation. A simple order from the hypnotizer is enough to throw the subject into the condition. Sometimes the habit is carried to such an extent that the subject is able to throw himself into the hypnotic condition. Such self-induced hypnosis is known as auto-hypnosis. The ability to produce the hypnotic state in the subject does not depend upon any peculiar powers on the part of the hypnotizer; it depends rather upon his ability so to influence his subject that the condition of partial sleep described shall be induced. The essential condition with which the subject himself must comply, in order to come under the influence of a hypnotizer, is that he concentrate his attention. The only persons who cannot be hypnotized are young children, idiots, and insane persons, all of whom are unable to concentrate attention. This statement effectually disposes of the popular belief that only weak-minded persons can be hypnotized. The most effective method of avoiding hypnosis is to scatter attention as much as possible over a great variety of objects. Concentration of attention is always favorable to hypnosis and allied conditions. The audience which gives close attention to a speaker or performer is susceptible to a species of hypnosis; while, on the other hand, there is no danger of hypnosis in a distracted audience. The methods of inducing hypnosis have been accidentally discovered from time to time by performers who are then able to give striking exhibitions of their discovery. Many oriental jugglers begin their performance, the success of which undoubtedly depends upon their hypnotic influence over their audiences, with a dance in which the body of the performer is moved with a gradually increasing speed, which inevitably induces a gradually increased concentration of attention on the part of the observer. When this dance grows more and more rapid and more and more engaging to the attention, the observer is completely mastered and the main performance may be undertaken. The hypnotic influence of such a dance is very frequently augmented by the burning of incense, which has more or less of a narcotic effect upon the observers. In like manner, certain animals are probably drawn into a hypnotic state by the movement of snakes. This has frequently been reported in the case of birds and monkeys.

Various characteristics of the hypnotized subject.—When the hypnotic state has been produced, the phenomena exhibited are of two distinct types. First, there is a suspension of certain activities, and, secondly, there is an abnormal heightening of other activities. This may be seen with reference to the reception of sensory stimulations. Certain stimulations are no longer received by the hypnotized subject. For this reason the condition has sometimes been used by savage tribes for surgical purposes, exactly as in modern life we use drugs which will produce a dissociation of the nervous system and thus prevent pain from excessive external stimulation. On the other hand, certain other senses may be opened to stimulation. A hypnotized subject may be wholly anaesthetic in his skin, while still retaining the ability to receive impressions through certain of his other senses. Indeed, the concentration of nervous activity in certain particular senses results in such a heightening of their ability to receive impressions that the subject may perform most astonishing feats of sensory receptivity. He may hear very faint sounds or he may see remote visual objects. It is to be noted that this hyperaesthesia of the senses is not so extraordinary as it would at first sight seem to be. We all become hyperaesthetic when we concentrate attention in any direction. If one is listening for an important signal or watching for some object which is of great importance to him, he will be using his nervous energy in the emphasized direction and will be correspondingly impervious to impressions from other sources. The conditions in hypnosis are merely exaggerations of those which appear in ordinary life.

Ideas not subjected to criticism in hypnosis.—Turning from the sensory processes to the central processes, we find again that certain activities are entirely in abeyance, while others are much intensified. If, for example, it is suggested to a hypnotized subject that he is an animal instead of a human being, the suggested idea may take such large possession of him as to command his whole attention and guide his activity. If a normal individual is told that he is an animal, he immediately brings to bear upon the suggested idea a great variety of incompatible experiences, which make it clear that the statement is false and unacceptable. In the case of the hypnotized subject, very much as in the case of the dreamer, the corrective ideas, which constitute the fabric of normal life, are absent, so that the single idea takes full possession of the mind and commands belief as the accepted content of consciousness. This credulousness of the hypnotic consciousness is described by saying that the subject is very open to suggestion. Anything that is said to him will be accepted, and any form of interpretation of experience which is offered to him will be taken up without serious question and without any effort on his part to criticize the ideas which have been given him by the hypnotizer. Suggestibility has very frequently been emphasized to the exclusion of the converse fact that the hypnotized subject is quite incapable of subjecting any ideas to critical comparison. So also the positive increase in sensitivity has been the impressive fact; the diminution of sensibility has often been overlooked. The negative considerations are, however, essential to a complete understanding of the case, just as the negative considerations are of importance if we would understand the credulousness exhibited in dreams.

EXERCISE

1. A person in a state of abstraction or absent-mindedness may do many peculiar things, e.g., put sugar in his soup, try to light his cigar with a latch key, and the like. What are the similarities and differences between such behavior and that of the hypnotized subject?

11. THE "WISH"[1]

BY JOHN BROADUS WATSON

"If wishes were horses beggars would ride" is a nursery saw which, in the light of recent developments in psychology, has come to have a much more universal application than it was formerly supposed to have.

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[1] Taken from "The Psychology of Wish Fulfilment," *Scientific Monthly*, III (1916), 479–80.

If the followers of the Freudian school of psychologists can be believed—and there are many reasons for believing them—all of us, no matter how apparently contented we are and how well we are supplied with the good things of the earth, are "beggars," because at one time or another and in one way or another we are daily betraying the presence of unfulfilled wishes. Many of these wishes are of such a character that we ourselves can not put them into words. Indeed if they were put into words for us we should straightway deny that such a wish is or was ever harbored by us in our waking moments. But the stretch of time indicated by "waking moments" is only a minor part of the twenty-four hours. Even during the time we are not asleep we are often abstracted, day-dreaming, letting moments go by in reverie. Only during a limited part of our waking moments are we keenly and alertly "all there" in the possession of our faculties. There are thus, even apart from sleep, many unguarded moments when these so-called "repressed wishes" may show themselves.

In waking moments we wish only for the conventional things which will not run counter to our social traditions or code of living. But these open and above-board wishes are not very interesting to the psychologist. Since they are harmless and call for the kinds of things that everybody in our circle wishes for, we do not mind admitting them and talking about them. Open and uncensored wishes are best seen in children (though children at an early age begin to show repressions). Only to-night I heard a little girl of nine say: "I wish I were a boy and were sixteen years old—I'd marry Ann" (her nine-year old companion). And recently I heard a boy of eight say to his father: "I wish you would go away forever; then I could marry mother." The spontaneous and uncensored wishes of children gradually disappear as the children take on the speech conventions of the adult. But even though the crassness of the form of expression of the wish disappears with age, there is no reason to suppose that the human organism ever gets to the point where wishes just as unconventional as the above do not rise to trouble it. Such wishes, though, are immediately repressed; we never harbor them nor do we express them clearly to ourselves in our waking moments.

The steps by which repression takes place in the simpler cases are not especially difficult to understand. When the child wants something it ought not to have, its mother hands it something else and moves the object about until the child reaches out for it. When the adult strives for something which society denies him, his environment offers him, if he is normal, something which is "almost as good," although it may not wholly take the place of the thing he originally strove for. This in general is the process of substitution or sublimation. It is never complete from the first moment of childhood. Consequently it is natural to suppose that many of the things which have been denied us should at times beckon to us. But since they are *banned* they must beckon in devious ways. These sometime grim specters both of the present and of the past can not break through the barriers of our staid and sober waking moments, so they exhibit themselves, at least to the *initiated*, in shadowy form in reverie, and in more substantial form in the slips we make in conversation and in writing, and in the things we laugh at; but clearest of all in dreams. I say the meaning is clear to the initiated because it does require special training and experience to analyze these seemingly nonsensical slips of tongue and pen, these highly elaborated and apparently meaningless dreams, into the *wishes* (instinct and habit impulses) which gave them birth. It is fortunate for us that we are protected in this way from having to face openly many of our own wishes and the wishes of our friends.

EXERCISES

1. Distinguish between the use of the term "wish" in the passage above and its use in everyday speech.
2. It is sometimes said that an idea of an act tends to be followed by that act unless inhibited by a contrary idea. What light does that statement throw upon the fact that we all have "wishes" that must be suppressed?

12. THE EXPRESSION OF WISHES[1]

A. Slips of Everyday Life

BY JOHN BROADUS WATSON

In social gatherings where there is some slight emotional strain and the customary control over speech is off, we find numberless examples of the expression of the suppressed wish. If we were to make a tabulation of such slips met with in a single week, the list would be long. Most of the slips reveal too much to be put down in print. But I can mention some of the types usually met with.

An elderly bachelor, the friend of the family, squires his friend's wife to a dance. He introduces her as "Mrs. S." (giving her maiden name instead of her married name, "Mrs. J."). If taxed with possessing the wish that the woman were single so that he might have another chance, he would indignantly deny that any such thought had ever crossed his mind. This is probably true in the sense that had any such wish crossed his mind in his ordinary waking moments it would have been put down immediately—repressed. It is rather interesting to note in the above case, which is an actual one, that later in the evening the "Mrs. J." referred to, after having danced with a man other than her escort, shortly afterwards introduced her partner as "Mr. J." (her husband)! It is of course unusual to find material so readily as this. I noted another and common type of slip the same day as the above. A woman of my acquaintance had to go to the New York Central Station to meet three girl friends *en route* from Boston to Washington. She decided to buy some flowers for each of them. I went to the florist shop with her and to my surprise she purchased only two bouquets, saying: "*A* likes violets, but *B* is fond of orchids." When we reached the sidewalk I asked her why she disliked "*C*" so much. "Why do you think I dislike her?" she asked. "Because," I said, "you have done all in your power to annihilate her—you have forgotten to purchase any flowers for her." She showed confusion but gracefully admitted that I had saved her from making a serious *faux pas.* To take revenge, however, she gave me my just deserts by saying: "I can't bear to be around a man who has your view of life." (She afterwards admitted, however, that "*C*" had been for many years a thorn in the flesh.)

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[1] Taken from *op. cit.*, pp. 481–82.

Slips are often expressive of wishes which bear on the pleasanter side of life. I mislay my cane and umbrella, both of which I prize highly, and find that I left them at the house of a friend where I last had dinner and a game of bridge. The wish shortly to visit so pleasant a place again is very clearly implied. To take a single final example in this connection: Only a moment ago it was necessary for me to call a man on the telephone. I said: "This is Dr. John B. Watson, of the Johns Hopkins Hospital," instead of Johns Hopkins University. One skilled in analysis could easily read in this slight slip the wish that I had gone into medicine instead of into psychology (even this analysis, though, would be far from complete).

Slips of the pen are just as numerous and just as interesting revealers of hidden character as are slips in speech. It is in dreams, however, that we get our most interesting and valuable material for analysis.

B. The Dream as a Vehicle of Wish Fulfilment[1].

BY JOHN BROADUS WATSON

According to the now generally accepted viewpoint we dream almost constantly. If we were to put the question: "Do you often dream?" to a group of men, women and children, the answers would be various. Most of the men would say: "I seldom dream, and when I do my dreams are meaningless and uninteresting." Some of the women would say that they often have wonderful and thrilling dreams while others would maintain that their dreams were few and had no interest. The children would tell us that they dreamed frequently and that their dreams were always interesting and exciting. It is difficult to convince most adults that if they do not dream constantly they do dream much more frequently than they are at present aware of. Even my own students are at first sceptical about the universality of the dream processes. I ask them to try hard to recall their dreams on waking in the morning, and if they awake in the night to jot down a sentence or two of their dreams so that they can recall the whole dream on awaking in the morning. In a short time most of them are convinced that they do dream almost constantly.

If it is difficult to convince one that he dreams constantly, it is a Herculean task to convince him of the second step in understanding dreams—to wit, that his dreams are *not* at bottom bizarre and meaningless, but, on the contrary, that they are orderly, logical, and, if we know the history of the individual, almost predictable. We must admit immediately that if we take the dream at its face value, that is, read the words that the dreamer puts down as a true report of his dream, it is a creature of fancy in the wildest sense of that word. We get the reports in bits with no apparent connecting links. Fanciful words are put in. Names are mentioned which are the names of no individuals known to the dreamer. Places are visited which have never been visited by the dreamer. (Yet in almost every dream the starting point is some incident—situation, person, place, or thing—met with by the dreamer at some time not twenty-four hours before the dream took place.)

We get our clue to the dream as being a wish fulfilment by taking the dreams of children. Their dreams are as uncensored as is their conversation. Before Christmas my own children dreamed nightly that they had received the things they wanted for Christmas. The dreams were clear, logical and open wishes. Why should the dreams of adults be less logical and less open unless they are to act as concealers of the wish? If the dream processes in the child run in an orderly and logical way, would it indeed not be curious to find the dream processes of the adult less logical and full of meaning?

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[1] Taken from *op. cit.*, pp. 482–84.

This argument gives us good *a priori* grounds for supposing that the dreams of adults too are full of meaning and are logical; that there is a wish in every dream and that the wish is fulfilled in the dream. The reason dreams appear illogical is due to the fact that if the wish were to be expressed in its logical form it would not square with our everyday habits of thought and action. We should be disinclined to admit even to ourselves that we have such dreams. Immediately upon waking only so much of the dream is remembered, that is, put into ordinary speech, as will square with our life at the time. The dream is "censored," in other words.

The question immediately arises who is the censor or what part of us does the censoring? The Freudians have made more or less of a "metaphysical entity" out of the censor. They suppose that when wishes are repressed they are repressed into the "unconscious," and that this mysterious censor stands at the trapdoor lying between the conscious and the unconscious. Many of us do not believe in a world of the unconscious (a few of us even have grave doubts about the usefulness of the term consciousness), hence we try to explain censorship along ordinary biological lines. We believe that one group of habits can "down" another group of habits—or instincts. In this case our ordinary system of habits—those which we call expressive of our "real selves"—inhibit or quench (keep inactive or partially inactive) those habits and instinctive tendencies which belong largely in the past.

This conception of the dream as having both censored and uncensored features has led us to divide the dream into its specious or manifest content (face value, which is usually nonsensical) and its latent or logical content. We should say that while the manifest content of the dream is nonsensical, its true or latent content is usually logical and expressive of some wish that has been suppressed in the waking state.

On examination the manifest content of dreams is found to be full of symbols. As long as the dream does not have to be put into customary language, it is allowed to stand as it is dreamed—the symbolic features are uncensored. Symbolism is much more common than is ordinarily supposed. All early language was symbolic. The language of children and of savages abounds in symbolism. Symbolic modes of expression both in art and in literature are among the earliest forms of treating difficult situations in delicate and inoffensive ways. In other words, symbols in art are a necessity and serve the same purpose as does the censor in the dreams. Even those of us who have not an artistic education, however, have become familiar with the commoner forms of symbolism through our acquaintance with literature. In the dream, when the more finely controlled physiological processes are in abeyance, there is a tendency to revert to the symbolic modes of expression. This has its use, because on awaking the dream does not shock us, since we make no attempt to analyze or trace back in the dream the symbol's original meaning. Hence we find that the manifest content is often filled with symbols which occasionally give us the clue to the dream analysis.

The dream then brings surcease from our maladjustments: If we are denied power, influence, or love by society or by individuals, we can obtain these desiderata in our dreams. We can possess in dreams the things which we can not have by day. In sleep the poor man becomes a Midas, the ugly woman handsome, the childless woman surrounded by children, and those who in daily life live upon a crust, in their dreams dine like princes (after living upon canned goods for two months in the Dry Tortugas, the burden of my every dream was food.) Where the wished-for things are compatible with our daily code, they are remembered on awaking as they were dreamed.

C. Wit and Humor[1]

BY EDWIN B. HOLT

Another phenomenon which shows the working of subterranean forces in character is that of wit and humor. After reviewing the long list of theories and definitions of humor, which is as dense a jungle of misconception as anywhere exists, Freud caps them all with his simple formula that every form of wit or humor is nothing but a means of "letting the cat out of the bag." But what cat, what bag, and what are the means? The cat is one of these suppressed wishes, the bag is the confinement imposed by the vigilant censor, and the means are a variety of devices to trick the censor, particularly by taking advantage of the latter's weak points. Thus the man who said, "The Rev. Mr.—'s prayer yesterday was the most eloquent prayer that has ever been presented before a Boston audience," was really charging the preacher with caring more about his audience than about God. But it eludes the speaker's censor because, firstly, the remark barely misses of conveying high praise; secondly, because the same or similar phrase with "sermon" put in the place of "prayer" is fairly habitual and not a few persons are able to rattle the remark off "without thinking." For precisely the same reasons it can be counted on to pass the censor of any one to whom it is addressed. In fact, while such a comment is as derogatory as it can well be, it is so nicely adjusted to the weaknesses of the average person's censor that probably even the preacher who was its victim would have been unable to take serious offense. Thus this sly tribute of praise gives vent to the teller's suppressed attitude of hatred (or it may be envy, etc.) without traversing any of the accepted social conventions. And the censor is generally strong on conventions.

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[1] Taken from *The Freudian Wish and Its Place in Ethics*, pp. 17–23. New York: Henry Holt & Co., 1915.

And, further, it clears the way for a similar release of suppressed wish in the person to whom the comment is made. The function of a joke in the inventor's mind and its rôle in the minds of those who hear or read it are not always identical. As to the former, of course, humor occurs spontaneously or not at all: one cannot grind out wit to order. At the most one can cultivate a facetious habit of mind, which means a censor that rigidly regards the conventions but imposes no more sincere check on illicit wishes. One can see this in many degrees, and one recalls that the "saint" is traditionally grave and shows no trace of facetiousness. Wit is never saintly, and is always sly; yet, as will appear, it need not be vicious. But to rack one's brains for a joke is to court the impossible. When a joke comes, it infallibly produces a smile even though the person be quite alone. I think there can be no doubt, although here I am going exactly counter to Freud,[1] that this is due to an overflow of energy from the hitherto suppressed wish into the facial muscles; why just these muscles is not known, although one gets a hint from Darwin's book on *The Expression of the Emotions in Man and Animals*. After this, if the suppressed wish is sufficiently relieved by the one discharge, the joke is forgotten and the smile fades; but if the wish has a larger store of pent-up energy, the joke lingers in the mind and the smile on the face; it may be for days. A person who is habitually in this condition is, in the vernacular, a "chucklehead." But, on the other hand, the censor may be aroused to greater vigilance, and the person "straightens out his face" and "sobers down." Just what shall happen depends on the relative strengths of the suppressed wish and of the censor, and on the amount of release which the joke affords as well as on the degree of violence which it does to the censor. A really "slick" piece of wit, like Mark Twain's "When in doubt, tell the truth," does no violence to anyone's censor, and is a perennial outlet for one's contempt of deceitful humanity. It is sly but not vicious. Freud here involves us in a doctrine of the "latent energy of suppressed wishes"; and although this may sound highly metaphorical, it is an exact statement and easily explained in the strictest physiological terms.

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[1] Freud, strangely enough as I think, refers the smile or laugh to energy coming from the censor and due to the latter's relaxing its hold on the suppressed wish.

The reception of a piece of humor by a second person is subject to the same principles, but the conditions present more chance for variation. In the first place, the recipient may not have any suppression such as the joke would release. At a dinner-table where the hostess was a Christian Scientist I once heard a professional diner-out relate how, in a Christian Scientist's family of his acquaintance, the pet cat had given birth to blind kittens. It was very sad. The "Science" healer was immediately consulted, and after ten days of absent treatment the kittens were restored to perfect sight. I tried in vain to kick the gentleman under the table as soon as I scented his drift, but he was not to be deterred; the joke was a frost; and after he departed the house rang with injurious comment:—he was a "wife-beater," and she poor thing, might even then be "committing suicide."[1] It is clear enough that a piece of humor will miss fire when fired at a person who has not the requisite suppressed complex. In the instance just given this second person had not only no such suppression but the very reverse, and the joke was taken for exactly what it was—an act of aggression against Christian Science. Clearly, then, humor can generally be passed only among persons of similar suppressions ("prejudices"); and one notes, in fact, that it flows freely in circles of intimate friends, while it gives place to stiff formality in other assemblies in proportion to the lack of an established congeniality. The man who wants to be witty before a large audience must limit himself to ventilating suppressions which are fairly common to the race. The safest way is to appeal to the Old Adam in us all which secretly regards the fellow-man as a rival and prospective antagonist. The Germans aptly name this principle "*Schadenfreude*," for which we seem to have no equivalent. Even here the censors are of different degrees of strictness and one must adapt one's *Schadenfreude* to the average censor of the audience. One person finds it excruciatingly funny to hear a wan and lonely old woman sitting down on a tack; while another can scarcely bear to hear that Mr. X., the once promising but now middle-aged and disappointed senator, "has a glorious future behind him."

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[1] And you, O Gentle Reader (to use an outworn mode), I fear may like this tale because it grants you three suppressed wishes—a dig at Christian Science, one at the venom of indignant hostesses, and a vision of the discomfiture of that ubiquitous nuisance, the professional funny-man. Yes, and a fourth, for it shows me foolishly trying to avert impending gloom by kicking vainly against the unfeeling air.

EXERCISES

1. Show by concrete examples not quoted above how slips, dreams, and jokes may express repressed impulses.
2. Why is the subtle joke considered "better humor" than the direct one?
3. How would you explain dreams in which one is badly frightened?

13. PSYCHOTHERAPY

A[1]

BY AARON J. ROSANOFF

Psychotherapy is the use of psychic factors in the treatment of disease.[2]

An essential element of psychotherapy is suggestion. Its successful practice is dependent on the nature of the disorder, the attitude of the patient, and the personality of the physician.

The patient must have full confidence in the physician and in his methods. "The nervous patient is on the path to recovery as soon as he has the conviction that he is going to be cured; he is cured on the day when he believes himself to be cured."

It follows that the physician must be able to inspire respect and trust. According to Griesinger he must have "a kind disposition, great patience, self-possession, particular freedom from prejudice, an understanding of human nature resulting from an abundant knowledge of the world, adroitness in conversation, and a special love of his calling."

As to the manner of employing suggestion the indications must be sought in the individual case. In some cases, the patient's faith being strong, a mere statement that the symptoms are quickly disappearing may be sufficient. In other cases "rational" suggestion with an explanation of the cause of the symptoms and of the best means of combating them is more effective. "There is a great difference in mentality between the man who is content with a statement, who allows himself to be under the influence of the personality of a healer, and the man who acquires confidence by the clear exposition of the reasons to believe." In still other cases hypnotic suggestion affords good results.

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[1] Adapted from *Manual of Psychiatry* (5th ed.), pp. 112–17. New York: John Wiley & Sons, 1920.

[2] Only certain types of nervous or mental diseases, of course, are amenable to psychotherapy.—EDITORS.

The following practical advice, evidently borne of abundant experience, is given by Dercum:

> The physician should not be too aggressive with his suggestions, especially in the beginning. Indeed, his attitude should be that of accepting the illness and symptoms of the patient as a matter of course. The mere institution of rest and the various physiological procedures, is a proof to the patient of the sincerity of the physician. It is only after the treatment has been established and has been under way for some time that the physician should begin a really serious psychotherapy. He should never be in a hurry to begin. The mistake may be beyond remedy, at least, so far as *he, individually,* is concerned. Time must be allowed for the patient to "settle down," i.e., to adapt herself to her new environment, her nurse and her physician. Very soon the luxuriousness and exquisite physical comfort of a properly instituted rest treatment makes its impression upon the patient. As the days go by, the physician and the patient gradually become better acquainted. The nurse, too, learns the little personal peculiarities of her patient, all of which she faithfully communicates to the physician. Very soon opportunities occur for more lengthy conversations, and the physician being now thoroughly *en rapport* with his patient and having fully gained her confidence, can venture to make free use of suggestion. Indirect suggestion, we will say, has been employed from the beginning, but direct suggestion, explanatory and logical in form, can now be employed with great effectiveness. Sometimes the conversations with the patient reveal the way in which this or that special symptom arose, and this clue may be of value in its subsequent disposal; the physician may point out the inadequacy of the cause alleged and at the same time "explain away" the sympton.

Special mention should be made of religious influences, which are of extraordinary efficacy in some cases. Cures produced by pilgrimages to shrines or by the practice of Christian Science are instances in point. Equally striking are the cures of habits of intemperance produced by religious conversion or, among good Catholics, by taking the pledge of total abstinence. In these, as in other measures of psychotherapy, the active principle is suggestion and therefore the existence of strong faith is a condition necessary for success.

In cases of mental deterioration the object of psychotherapy is re-education, not with the hope of bringing about recovery, but with that of training the subject to do some simple yet productive labor (basket weaving, mat making, chair caning, sewing, farm labor, etc.).

Delusional states are notoriously refractory to suggestion or reason. Yet in selected cases, in which the delusional system, is so to speak, of a parasitic nature, not essentially a function of a vicious mental organization, something may be accomplished when a favorable opportunity presents itself of demonstrating to the patient the incorrectness of his belief.

I shall quote from the published autobiography of a man who had suffered from a severe and prolonged manic-depressive psychosis from which he subsequently recovered.[1]

This man had developed a complex system of delusions of persecution by detectives. Within the space of a fraction of a minute he succeeded in fully correcting all his false ideas when he found convincing proof that he whom he had regarded as his brother's double and a detective was indeed his true brother.

> I dared not ask for ink, so I wrote with a lead pencil. Another fellow patient in whom I had confidence, at my request, addressed the envelope; but he was not in the secret of its contents. This was an added precaution, for I thought the Secret Service men might have found out that I had a detective of my own and would confiscate any letters addressed by him or me. The next morning, *my* "detective" (a fellow patient who had the privilege of going and coming unattended) mailed the letter. That letter I still have, and I treasure it as any innocent man condemned to death would treasure a pardon or reprieve. It should convince the reader that sometimes an insane man can think and write clearly. An exact copy of this—the most important letter I ever expect to be called upon to write—is here appended:
>
> August 29, 1902
>
> "Dear George:
>
> "On last Wednesday morning a person who claimed to be George M. Beers of New Haven, Ct., clerk in the Director's Office of the Sheffield Scientific School and a brother of mine, called to see me.
>
> "Perhaps what he said was true, but after the events of the last two years I find myself inclined to doubt the truth of everything that is told me. He said that he would come and see me again sometime next week, and I am sending you this letter in order that you may bring it with you as a passport, provided you *are* the one who was here on Wednesday.

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[1] C. W. Beers, *A Mind That Found Itself*, 1908. New York: Longmans Green & Co.

"If you did not call as stated please say nothing about this letter to anyone, and when your double arrives, I'll tell him what I think of him. Would send other messages, but while things seem as they do at present it is impossible. Have had some one else address envelope for fear letter might be held up on the way.

"Yours,
CLIFFORD, W. B."

Though I felt reasonably confident that this message would reach my brother, I was by no means certain. I was sure, however, that, should he receive it, under no circumstances would he turn it over to any one hostile to myself. When I wrote the words: "Dear George," my feeling was much like that of a child who sends a letter to Santa Claus after his faith in the existence of Santa Claus has been shaken. Like the skeptical child, I felt there was nothing to lose, but everything to gain.

The thought that I might soon get in touch with my old world did not excite me. I had not much faith anyway that I was to reestablish former relations, and what little faith I had was almost dissipated on the morning of August 30, 1902, when a short message, written on a slip of paper, reached me by the hand of an attendant. It informed me that my brother would call that afternoon. I thought it a lie. I felt that any brother of mine would have taken the pains to send a letter in reply to the first I had written him in over two years. The thought that there had not been time for him to do so and that this message must have arrived by telephone did not then occur to me. What I believed was that my own letter had been confiscated. I asked one of the doctors to swear on his honor that it really was my own brother who was coming to see me. He did so swear, and this may have diminished my first doubt somewhat, but not much, for abnormal suspicion robbed all men in my sight of whatever honor they may have had.

The thirtieth of the month was what might be called a perfect June day in August. In the afternoon, as usual, the patients were taken out of doors, I among them. I wandered about the lawn, and cast frequent and expectant glances toward the gate, through which I believed my anticipated visitor would soon pass. In less than an hour he appeared. I first caught sight of him about three hundred feet away, and, impelled more by curiosity than hope, I advanced to meet him. "I wonder what the lie will be this time," was the gist of my thoughts.

The person approaching me was indeed the counterpart of my brother as I remembered him. Yet he was no more my brother than he had been at any time during the preceding two years. He was still a detective. Such he was when I shook his hand. As soon as that ceremony was over he drew forth a leather pocket-book. I instantly recognized it as one I myself had carried for several years prior to the time I was taken ill in 1900. It was from this that he took my recent letter.

"Here's my passport," said he.

"It's a good thing you brought it," said I coolly, as I glanced at it and again shook his hand—this time the hand of my own brother.

"Don't you want to read it?" he asked.

"There is no need of that," was my reply. "I am convinced. . . . . "

This was the culminating moment of my gradual readjustment. . . . In a word, my mind had found itself.

B[1]

BY THEODORE HOUGH AND WILLIAM T. SEDGWICK

It has been shown that mental conditions have a direct influence upon the activities of the body, even leaving out of account the voluntary muscles. The effect of emotions upon the heart has been referred to, and so has the psychic secretion of gastric juice. It is known that the movements of the alimentary canal are readily modified by events in conscious life. In the hypnotic state the effect of suggestion upon functions which we habitually regard as involuntary is even more striking. Facts like these have led some to the rash assumption that there is no limit to the domination of the mind over physiological processes. Occasionally the ascendancy which some have gained over certain forms of disease has been as surprising to others as it has been gratifying to themselves. Beyond question the righting of disordered functions and the suppression of pain have been frequently attained, and this fact makes it easy to see why so great a following has been drawn to a belief in the unlimited possibilities of mental power.

Nevertheless certain dangers are always involved in the attempt to overcome disease by resolutely forgetting it and denying its existence. The feeling of pain may at times be banished by believing that it does not exist, *but this condition may be quite as undesirable as self-inflicted blindness or deafness.* While relief from pain may frequently favor recovery by promoting rest and nutrition, it may at other times simply mean the loss of warnings which deserve to be heard. Where there is grave organic disease, such as cancer, this may move on to a fatal issue even while the deluded subject consistently ignores or seeks to ignore its existence. It is not wise to try to annul the *effects* of a disease in consciousness when these effects *as well as their cause* can be removed by rational medical treatment. Hypnotism may relieve a toothache, but it is not claimed that it will mend a decaying tooth. The dentist's filling, which does both, is the type of medical as contrasted with psychical methods in dealing with acute disease. Especially foolish is it to ignore or deny the actual presence of infectious or contagious disease, for here delay menaces not only the patient but those about him. The consequences of this folly, when confined to its deluded victim, may end in virtual suicide; when they extend to others, they may fall little short of manslaughter.

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[1] Taken from *The Human Mechanism*, pp. 340–41. Boston: Ginn & Co., 1918

EXERCISE

1. For the cure of what kinds of disorders is psychotherapy useful? Where is it dangerous? Why?

14. THE READING OF CHARACTER FROM EXTERNAL SIGNS[1]

BY KNIGHT DUNLAP

It is actually a fact that we do make correct judgments about the transient mental processes of other persons without being able to identify the facts on which these judgments are based. If you are talking to some one, and you say something which offends or grieves or pleases him, you may recognize that fact at once, although it may be impossible for you to designate the exact change in his face or voice or posture which is the basis of your idea. You may even make similar judgments when carrying on a conversation over the telephone, in which case changes in the timbre and inflections of the voice alone could give you the clue. You know from the other person's voice that he is offended or pleased, although you may not be able to identify the exact change in his voice which is the important factor. When you have the visual clues from the other person's face, as well as the clues from his voice, your judgments are more definite and more secure.

This whole matter is but a special case of the more general phenomenon of perception and judgment by sign. It is a fact that in much of our perception we perceive meanings without perceiving the signs on which the perception is based. In some cases, the signs could be perceived, if attention were drawn to them; in other cases, the signs can not be discriminated even under the best conditions. I shall not go into this topic in an extended way, both because it is familiar to psychologists, and because it can not be briefly expounded to those without psychological training. I mention it only to show that on this point of character readings we are not dealing with a unique phenomenon, but with a particular manifestation of a general principle which runs broadly through our mental life.

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[1] Taken from "The Reading of Character from External Signs," *Scientific Monthly*, XV (1922), 162–64.

As another illustration of the general principle, I may refer to certain cases of supposed "thought-reading" which are really cases of sign-reading. Many amateurs succeed in catching ideas from other persons, where there is physical relation of such sort that movements of the second person may actually stimulate receptors of the first person, either tactually, visually or acoustically. But these amateurs never succeed if they watch for the signs. They succeed only when they ignore the signs and attend to the meanings. In fact, if amateurs who succeed brilliantly in muscle reading tests become convinced that their performance really is muscle reading and nothing more occult, they can usually do the trick no longer, and this is precisely what we might expect. Similarly, if, instead of watching to see whether the person you are talking to is pleased or not, you watch for the facial changes which indicate pleasure, you will not catch his emotional changes unless the symptoms are extremely gross. The conditions here are not greatly different from those obtaining in the visual perception of depth, where, if you attend to the signs, convergence, accommodation, binocular disparity, and so on, you will lose the depth-effect which those signs would give if they were not attended to.

The important question, therefore, is: What are the signs which tell us something about the mental characteristics of other persons? In the case of fleeting, ideational and emotional changes, these signs are obviously not anatomical; and in the case of fundamental tendencies of mental and moral sorts, we have already shown that there are no known anatomical signs. We are, therefore, forced to the conclusion that in the one case as in the other, the signs are physiological. Changes in the complicated muscular system of the face do occur along with ideas, especially if these ideas are emotionally toned. Changes in the complex musculature of the vocal organs and changes in the arm, leg and trunk muscles also occur. There are, in other words, changes in voice, in features, in posture and in other bodily postures and movements which are perfectly competent to serve as indexes of ideational and emotional changes. Unfortunately, we have not yet succeeded in analyzing more than the most gross of these signs.

Fundamental tendencies in ideational and emotional reaction give rise to habitual modes of expression of the various sorts. Habitual modes of expression, moreover, leave their traces, especially in the face, even when the actual expression is not occurring. There would seem to be, therefore, a complex system of signs, not only of fleeting mental changes, but signs also of character traits, provided we can make use of them.

Signs of this sort are effective, prior to analysis. Habits of perception and of judgment are built up on signs, without necessitating any analysis or identification of such signs. Moreover, the development of the capacity to catch meanings in this way, if it be possible, depends upon native capacity as well as upon practice. We should, therefore, expect to find exactly what we do find, namely, that there is great individual variation in this apparent skill, and that in the absence of a really comprehensive and accurate analysis of signs, the attempt to attend to signs is a disturbing factor.

EXERCISE

1. Why is it that one who reads character exceedingly well may explain his methods in a totally erroneous manner?

15. MEDIUMS AND TRICKSTERS[1]

BY EDWIN E. SLOSSON

Those who believe in spiritistic phenomena call upon their opponents to disprove their hypothesis, and hold, rightly enough, that if ninety-nine mediums are merely tricksters, it does not prove that the hundredth is not genuine. It is, of course, impossible to prove the universal negative of such a proposition. It is merely a question of probabilities. We can merely say that if spirits do return, it is extremely unfortunate that they can only return under those conditions which are most favorable for deception.

What these conditions are we can learn from the practices of amateur and professional conjurers. Let us approach the matter from another starting point than is usually adopted. Instead of speculating as to how departed spirits would manifest themselves to us, a matter which we can know nothing about, let us consider what a trickster would do if he wished to deceive the public into thinking that he was possessed of spirit power, a matter on which we have unfortunately a great deal of information. What conditions would he impose? What methods would he use? The following are the chief characteristics of such fraudulent manifestations:

(1) Darkness. The less the light the more remarkable the manifestations is the general rule.

(2) Distraction of attention. This is the chief reliance of the parlor and stage magician. The most striking things in the seance room occur after the sitters are tired of watching.

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[1] Taken from "Mediums and Tricksters," *Scientific Monthly*, XV (1922), 285–87.

(3) Unexpectedness. An experimenter lets us know what effect he is trying to get, and even if the experiment does not work he does not palm off some entirely different phenomenon and claim he has succeeded. The feats of the conjurer—and of the medium—are capricious and unforeseen. That is why trickery can not be guarded against by precautions in advance.

(4) Control of Conditions. The conjurer and the mediums alike insist on having lights, furniture, sitters and apparatus arranged to suit themselves. On the other hand, the primary requisite of an experiment is the control of conditions. It is, therefore, incorrect to speak of experiments with mediums. They are usually merely observations, and that under circumstances most unfavorable to correct observation.

(5) Suggestion. This is the main reliance of the magician, next to distraction of attention. He palms a coin while pretending to throw it into a hat or into the air. Our eyes follow the motion of his hand and interpret it according to the intent. It is easy under favorable circumstances to cause collective hallucinations of smell, sight or sound. Our sense of hearing is particularly liable to be deceived as to the character and direction of sound, such as the raps and scratches which are the commonest of mediumistic phenomena.

(6) Concealment. A prestidigitator for his most difficult tricks requires some kind of a table, shelf or screen, but he rarely demands so convenient a shelter as the medium's cabinet or curtain.

(7) Tied or held hands. The releasing of hands and feet when they are bound, knotted and sealed is the cheapest of tricks. I have seen a man handcuffed by a policeman, tied in a bag and thrown into the river, yet he came to the surface promptly with his hands free.

(8) Involuntary assistance. The respectable and well-meaning gentlemen whom the audience select to represent them on the stage do not interfere with the magician. On the contrary, they often aid as well as give countenance. The magnetic girl who used to throw strong men about the stage was really utilizing their strength, not her own. Where several persons have their hands on a table it is impossible to prevent their taking an active part in its motion.

(9) Emotional excitement. An experimenter must preserve a cool and somewhat detached demeanor. Now, even the most convinced skeptic can not witness unmoved such violations of natural law as these, purporting to prove the existence of another world, and especially the presence of his deceased friends and relatives. The

photographs taken of the seance room show us not merely that the table is suspended in mid air, but that the witnesses, watching it with bulging eyes, open mouths and strained attention, are incapable of critical observation.

In these nine points and others the conditions of successful trickery and the conditions of the seance are the same. For that reason and others most scientists do not think it worth while to spend their time on spiritualism.

EXERCISE

1. Explain why so many people believe in such alleged occult phenomena as telepathy, prophecy, and the like.

CHAPTER XXI

INDIVIDUAL DIFFERENCES AND THEIR MEASUREMENT

1. INSTANCES OF INDIVIDUAL DIFFERENCES

A[1]

BY WILHELM WUNDT

Astronomers had noticed certain sources of error in the temporal determination of movements of the heavenly bodies which, while they tended to invalidate the objective value of an observation, cast at the same time a most instructive light upon the subjective peculiarities of the observer.

Suppose that we have to determine the time of the passage of a star at some distance from the pole across the meridian. We may employ an old astronomical method, which is still sometimes used for temporal determinations, and which is called the "eye and ear method." A little before the time of the expected passage, the astronomer sets his telescope, in the eye-piece of which there have been fixed a number of clearly visible vertical threads, in such a way that the middle thread exactly coincides with the meridian of the part of the sky under observation. Before looking through the instrument, he notes the time by the astronomical clock at his side, and then goes on counting the pendulum-beats while he follows the movement of the star. Now the time-determination would be very simple, if a pendulum-beat came at the precise moment at which the star crosses the middle thread. But that, of course, happens only occasionally and by chance: as a rule, the passage occurs in the interval between two beats. To ascertain the exact time of the passage, therefore, it is necessary to determine how much time has elapsed between the last beat before the passage and the passage itself, and to add this time,—some fraction of a second,—to the time of the last beat. The observer notes, therefore, the position of the star at the beat directly before its passage across the middle thread, and also its position at the beat which comes immediately after the passage, and then divides the time according to the length of space traversed. If *f* (Fig. 99*a*) is the middle thread of the telescope, *a* the position of the star at the first beat and *b* at the second, and if *a f* is, e.g., twice as long as *fb*, there must be added $\frac{2}{3}''$ to the last counted second.

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[1] Taken from *Lectures on Human and Animal Psychology*, pp. 267–68. (Translated from the second German edition by J. E. Creighton and E. B. Titchener.) London: George Allen & Co., 1912.

When the errors dependent upon accidental circumstances have all been eliminated, these measurements still show differences between different observers. They persist even when there is no external reason discoverable. The fact was first noticed in the annals of the Greenwich Observatory for 1795. The astronomer writes that he dismissed his assistant as unreliable because he had acquired the habit of seeing all stellar transits half a second too late. Not till many decades later was the scientific honour of the assistant vindicated. It was the celebrated German astronomer Bessel who proved that this difference between two observers is only a special case of a phenomenon of universal occurrence. Bessel compared his own results with those of other astronomers, and came to the surprising conclusion that it is hardly possible to find two observers who put the passage of a star at precisely the same time, and that the personal differences may amount to a whole second. These observations were confirmed at all observatories, and in the course of the experiments many other interesting facts came to light. It was found, for instance, that the personal difference between two observers is a variable quantity, fluctuating, as a rule, but little in short periods of time, but showing larger variations in the course of months and years.

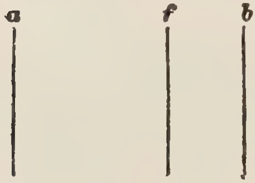

Fig. 99*a*

B[1]

BY EDWARD L. THORNDIKE

A CONCRETE ILLUSTRATION OF THE PROBLEMS OF INDIVIDUAL DIFFERENCES

The best means of introduction to the study of individual differences, their causes and their educational significance, will be to examine an actual first-hand study of them. For this purpose I choose certain parts of Mr. S. A. Courtis' report on the arithmetical abilities of children in the schools of New York City.

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[1] Adapted from *Educational Psychology; Mental Work and Fatigue and Individual Differences and Their Causes*, III, 144–51. New York: Teachers College, Columbia University, 1914.

Mr. Courtis measured the achievements of pupils in responding to eight tests. Test 7 is reproduced below.

ARITHMETIC—TEST NO. 7. FUNDAMENTALS

Name..................... *School*.................. *Grade*..........

In the blank space below, work as many of these examples as possible in the time allowed. Work them in order as numbered, writing each answer in the "answer" column before commencing a new example. Do no work on any other paper

Number	Operation	Example	Answer	Right
1....	Addition	*a*. $25+830+122=$ *b*. $232+8021+703+3030=$	....	....
2....	Subtraction	*a*. $5496-163=$ *b*. $943276-812102=$	....	....
3....	Multiplication	$2012\times 213=$	......	......
4....	Division	$158664\div 132=$	......	......
5....	Addition	$6134+213+4800+6005+3050+474=$	......	......
6....	Subtraction	$73210142-49676378=$	......	......
7 8 ...	Multiplication	$46508\times 456=$	......	......
9....	Division	$27217182\div 6=$	......	......
10 11 ...	Division	$3127102\div 463=$	......	......
12 13 ...	Addition	$85586+69685+39397+95836+37768+69666+78888+54987=$	......	......
14....	Subtraction	$15655431-5878675=$	......	......
15 16 ...	Multiplication	$78965\times 678=$	......	......
17....	Division	$44502486\div 7=$	......	......
18 19 ...	Division	$5373003\div 769$	......	......

Consider now the results of Test 7 in a certain eighth-grade class as shown in Fig. 100. Consider also Table XVIII, which gives similar facts for all the eighth-grade children tested. The picture and this table state an important fact—the existence of great individual differences even among those of the same school grade, and so of roughly similar training in arithmetic—and suggest at least two important questions. The first question concerns the meaning of the score used; the second concerns the comparative effects of (*a*) differences in original capacities and (*b*) differences in the circumstances of life and training in producing the differences that are actually found between one human being and another.

The score used here is the number of examples done correctly (certain more difficult examples counting each as 2). Elsewhere Mr. Courtis reports also the number of examples "attempted" but not completed with a correct answer. Now, obviously, the individual

TABLE XVII

Score	No. of children Making Each Score
17	1
16	1
15	0
14	1
13	3
12	3
11	4
10	8
9	4
8	4
7	6
6	4
5	6
4	2
3	0
2	1

abilities reported in Fig. 100 and in Table XVIII might be more widely scattered or be more closely clustered if some credit were given for the amount achieved in each example not completed with a correct answer. Moreover, obviously, "to do correctly 16 examples" need not mean to have eight times as much ability, or to achieve eight times as much, as "to do correctly two examples in the same length of time," in any absolute sense. We cannot assume that, if A takes eight times as long as B to run a mile, to write an equally good epic poem, to discover the cure for cancer, to translate a page of Latin, to add a column of figures, to eat his meals, and to make up his mind to give all that he has to the poor, B's achievements or abilities as runner, poet, scientist, translator, adder, and B's appetite and charity, are in each case eight times as far above zero as A's.

We have seen that where an individual's condition at one time is compared with his condition at another, the comparison must be made with recognition of the nature of the score used. So, also, when one individual's condition is compared with another's. All thought about individual differences must allow for the meaning of the scales and scores used.

TABLE XVIII

The Variation among Eighth-Grade Pupils in Arithmetical Computation (after Courtis)

"Score" or "Quantity": Examples Done Correctly in 12 Minutes in the Case of Test 7	Number of Children Making Each Score or "Frequency": Eighth-Grade Children in New York City
19	31
18	25
17	86
16	107
15	182
14	251
13	327
12	390
11	453
10	497
9	475
8	425
7	333
6	312
5	239
4	152
3	88
2	71
1	30
0	28

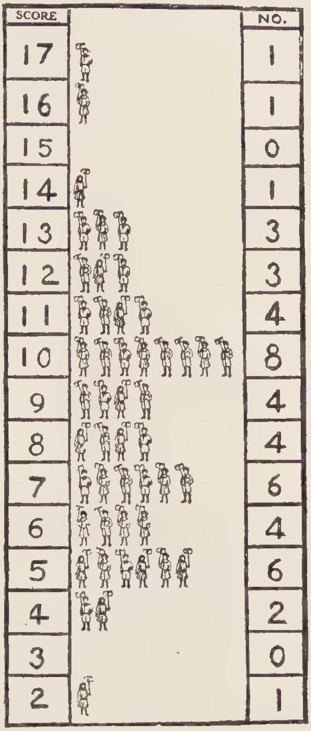

Fig. 100.—The variation in ability within a single class. (After Courtis.)

The second problem suggested—of the division of responsibility for individual differences between original nature and environment or nurture—can be only suggested, not solved, by these data themselves. The wide range of achievement of pupils of roughly the same school training suggests that differences born in them play a large part in determining the differences eventually found in them. This is emphasized by the extensive "overlapping" of the scores from pupils of any grade, by the scores from pupils of lower grades shown in Table XIX.

Thus, some of the pupils in Grade 4 made even better scores (in number of correct answers obtained) than the average pupil of Grade 8. The difference between the best and the worst score in the same grade is three times the difference between the average score of the eighth grade and the average score of the fourth grade. And we shall later find other evidence leading to the same conclusion. The problem of the exact relative shares of nature and nurture is, however, a very complex and difficult problem, requiring elaborate consideration.

TABLE XIX

THE OVERLAPPING OF LOWER AND HIGHER GRADES IN ARITHMETICAL COMPUTATION (AFTER COURTIS)

SCORE OR QUANTITY	FREQUENCY		
Examples Done Correctly in 12 Minutes in the Case of Test 7	In the Fourth Grade	In the Sixth Grade	In the Eighth Grade
19	1	3	31
18			25
17	1	10	86
16	1	17	107
15		30	182
14		62	251
13	6	106	327
12	9	134	390
11	31	304	453
10	42	358	497
9	132	505	475
8	280	647	425
7	405	685	333
6	487	620	312
5	645	571	239
4	661	494	152
3	690	388	88
2	654	306	71
1	628	203	30
0	723	227	28

Another problem in the causation of individual differences is illustrated by Mr. Courtis' tables comparing the two sexes. I quote (in Table XX) the one for Test 6 in the VII B grade.[1]

It appears that in the number of examples attempted there was little or no difference between the sexes, but that in the number of

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[1] Test 6 was as follows:

Do not work the following examples. Read each example through, make up your mind what operation you would use if you were going to work it, then write the name of the operation selected in the blank space after the example. Use the correct answers the boys did somewhat better than the girls of the same grade.

TABLE XX

Sex Differences in a Speed Test in Reasoning: Boys and Girls in the VII B Grades Compared (after Courtis)

Quantity: Number of Examples Attempted in Test 6 in 1 Minute	Frequency in VII B Grade		Quantity: Number of Examples Done Correctly in Test 6 in 1 Minute	Ferquency in VII B Grade	
	Boys	Girls		Boys	Girls
16	1	6	16	1	....
15	....	....	15	....	....
14	1	....	14	....	....
13	4	3	13	....	....
12	7	6	12	1	1
11	7	11	11	....	2
10	15	18	10	6	4
9	34	21	9	10	4
8	59	52	8	23	11
7	119	88	7	50	24
6	240	216	6	110	61
5	287	273	5	197	132
4	238	230	4	245	197
3	161	172	3	245	236
2	55	65	2	201	273
1	6	6	1	113	175
0	1	1	0	33	48

The effects of sex, whether by inherited sex qualities or by the circumstances in which training differs for the sexes, have been the subject of many speculative opinions and of some few impartial investigations.

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following abbreviations:—"Add." for addition, "Sub." for subtraction, "Mul." for multiplication, and "Div." for division.

1. The children of a school gave a sleighride party. There were 9 sleighs used, and each sleigh held 30 children. How many children were there in the party?..............................

2. Two school-girls played a number game. The score of the girl that lost was 57 points and she was beaten by 16 points. What was the score of the girl that won?......................

3. A girl counted the automobiles that passed a school. The total was 60 in two hours. If the girl saw 27 pass the first hour how many did she see the second?............................

4. On a playground there were five equal groups of children each playing a different game. If there were 75 children altogether, how many were there in each group?..................

Operation	

And so on for twelve similar examples.

The influence of remote ancestry or race could be studied similarly by comparing two groups of children of the same sex, age, and training, but different in that the one group sprang from, say, East European Hebrews and the other from, say, North American Indians.

Other possible causes of differences in arithmetical achievement are:—differences in near ancestry or "family," differences in maturity, and differences in the length of time devoted to arithmetic in the schools, in the methods used in teaching it, or in other circumstances of training.

EXERCISES

1. Enumerate some ways in which individuals differ not mentioned above.
2. Enumerate some causes of individual differences not mentioned by Professor Thorndike.

2. THE DISTRIBUTION OF HUMAN TRAITS[1]

BY FORREST A. KINGSBURY

If people were all cast in the same mold, there would be no need of tests or other selective devices; knowing one, we should know all. But individuals are not all alike. From whatever point of view we compare and measure them they are found to vary widely. When a group is measured as to any one particular trait a few individuals will be found to manifest that trait in exceptionally high degree. A few others will be found almost or completely lacking in that trait. Most will be found to reveal it in some degree between these extremes.

Such variability characterizes any trait we care to name, whether physical or mental. It is a commonplace that no two people look exactly alike. It is no less true that no two people are precisely alike in any other trait, hereditary or acquired, although the differences between them may range from infinitesimal to great. Human traits are, moreover, practically countless in their number and diversity. The farther we carry our analysis of human personality the more numerous become the specific habits, abilities, and dispositions which we may enumerate, and which may contribute, positively or negatively, to vocational fitness. When we multiply by several hundred or several thousand such highly specialized traits as "ability to add quickly long columns of 3- or 4-digit numbers," or "tendency to use caution in approaching a grade crossing when driving a motor truck," we begin to realize the tremendous complexity of the problem of testing all—or even the most important—traits which may be of vocational significance.

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[1] From "Psychological Tests in Business: I, The Nature of Psychological Tests," *University Journal of Business*, I (1923), 249–81.

One of the commonest mistakes in interpreting the results of tests arises from the failure to recognize adequately this rich diversity of human traits. It is easy to assume that because an individual ranks low on a general intelligence test he must therefore be of low ability in every direction. True, he may be. Psychologists do not take much stock in Emerson's "Law of Compensation." But psychologists do recognize that inferior ability in one direction not infrequently goes hand in hand with superior ability in others. There are and must be many kinds of tests, more than we have today, if we are to measure all aspects of human nature.

Let us note in passing that measuring these traits by no means implies placing a corresponding moral or social valuation on them. "Superior" scores and "inferior" scores refer primarily to amount, not to value. Whether high scores are or are not desirable—and they may be either—depends on the purpose for which we would use them.

DISTRIBUTION TABLES AND CURVES

It is most useful, when attempting to measure any of these traits in a group of people, to reduce them to quantitative terms and to show the distribution of the various degrees either in a distribution table or a distribution curve. As an illustration of these two ways we may show the scores made by 367 pupils of the same school-grade on an intelligence test.

Test-Score	Number of Individuals
0 to 9	2
10 to 19	14
20 to 29	42
30 to 39	83
40 to 49	76
50 to 59	75
60 to 69	45
70 to 79	25
80 to 89	5

Or the same facts may be expressed in the form of a distribution curve.

It is evident that to say of a pupil, "He is in such-and-such a school-grade" tells little or nothing about his degree of intelligence. One pupil will be able to solve several times as many of the problems in an intelligence test as another in the same grade. Certainly no one expects the same performance in school work of these two. If their relative ability remains constant, we need not expect the same performance of these two when they enter business. One will be able to meet with comparative ease difficult situations in which the other will be utterly at sea. A distribution table or curve for any other of the hundreds of psychological traits we might name would show similar form.

Certain other facts about the distribution of individual abilities can be pointed out. When we measure the individual heights of a thousand men, we find that their measurements do not fall into sharply distinguishable classes—so many exactly 66 inches, so many 67 inches, and so on. The measurements shade into one another by imperceptible degrees; they are continuous, not discrete. The same thing holds true for any trait, physical or mental, we want to measure. Ordinarily this is not a matter of serious concern. But if we try to classify people into a few distinct classes, we find it a very difficult task, since this continuous nature of individual differences compels us to put in one class people who are hardly perceptibly lower than those we put in the class above. Making distinctions under such conditions, particularly when dealing with traits of social importance, is often distasteful, though unavoidable.

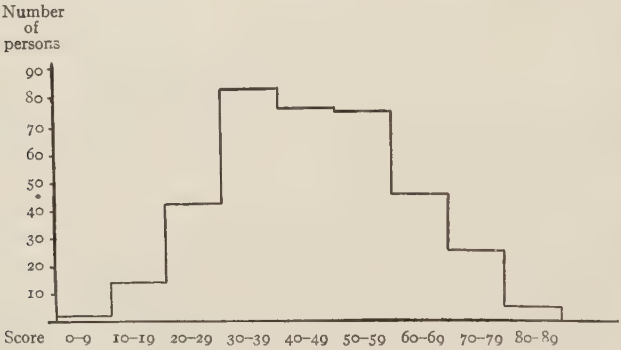

FIG. 101

We can point out still another characteristic of these measurements. While they cover a wide range, they are not distributed uniformly from high to low, but tend to concentrate around the average. That is, most men are neither tall nor short, but of about average height. A smaller number are noticeably above the average or below the average.

Still fewer are extremely tall or extremely short. Likewise with intelligence, or any other trait, as shown in the distribution curve just presented, the majority are of medium intelligence; a smaller number are bright or dull. A very few are exceptionally bright or exceptionally dull, including feeble-minded. This bell-shaped curve is the most common form of distribution of any trait. If we use large enough numbers of individuals and make our units of measurement fine enough, the distribution curve tends to become smoother and more truly "bell-shaped" in appearance, revealing clearly the continuous nature of the distribution. But for smaller numbers, of course, chance variations will be proportionately magnified and our curve will take a less regular form.

EXERCISE

1. What light is thrown by the foregoing discussion on the popular assumption that most individuals conform to some distinct type?

3. SOME PRINCIPLES OF HUMAN MEASUREMENT[1]

BY EDWARD L. THORNDIKE

A difference in human nature may be (1) in the amount or degree of the same thing[2] (as "good—better," "quick—slow," "imaginative—less imaginative—unimaginative"); or (2) in the presence or absence of different things (as "John knows Latin; James knows German," or, "A is imaginative; B is rational," or, "C has an artistic temperament; D has a scientific temperament").

The second case commonly reduces to an aggregate of differences of the first sort if the statement of difference is made adequate. Thus, "John knows x Latin; James knows o Latin; James knows y German; John knows o German" should properly replace the former statement. Similarly we have, "A is imaginative to z extent, B is imaginative to $z-w$ extent. B is rational to v extent; A is rational to $v-w$ extent," and, "C has r, y and z amounts respectively, of certain qualities, certain degrees of which in combination we call the artistic temperament; D has small or possibly zero amounts of these qualities." A difference in human nature then commonly is a difference in the amount of one thing or an aggregate of differences each in the amount of one thing.

But conceivably there may be things which do not vary in amount except from *zero* by a sudden jump to one positive condition. The thing would then either be in one constant degree or not at all. The literature of psychology and of education abounds in cases of difference stated as if the difference were that between o and k, without $k-1/10$, or $k-2/10$, or $0+1/8k$, etc. But such statements are usually due to ignorance or vagueness. "John is color blind; James is not" cannot really mean that there is some one constant degree of color blindness which a man either has just in that degree or does not have at all; for there are varying amounts of color blindness. In fact, it is doubtful if there are any individual differences in human intellect or character of this "*zero* to k" sort.

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[1] Adapted from *op. cit.*, pp. 152–60.

[2] Or what is assumed to be the same thing.

When, therefore, it is stated that John and James differ in *kind*, the statement always, or almost always, means nothing more than that one of the two individuals possesses a certain amount or degree of something of which the other possesses o. When it is stated that the difference between John and James in one thing, say, knowledge, is *qualitative* whereas their difference in another, say, motor skill, is *quantitative*, the statement always, or almost always, means nothing more than that certain sorts of knowledge, present in certain amounts in John, are absent in James, and vice versa; whereas, in motor skill, both have perceptible amounts of an identical set of things.

It is then not only permissible, but more scientific and more useful, to think of human individuals as all measured upon the same series of scales, each scale being for the amount of some one thing, there being scales for everything in human nature, and each person being recorded as *zero* in the case of things not appearing in his nature. And the only problem of method which need concern us here is the problem of the nature and use of a scale for measuring different amounts or degrees of the same trait in different human beings.

Units and Scales for Measuring Mental Differences

The facts of importance about scales for mental and moral traits can be best stated in connection with some concrete illustrations.

Consider the facts given in Table XXI concerning individuals A, B and C, with reference to these questions:—

1. What are the differences between A and B, A and C, and B and C in each of the traits?

2. How many times as great is the difference between A and B in trait I as that between B and C in trait I? How many times as great is the difference between B and C in trait II as that between A and C in trait II, etc., etc.

What the difference is between A and B can be definitely determined in the case of stature (I), reaction-time (II), error in drawing a line (III), and age (XII); but all that one learns about the differences in the case of ability in history (VII) and interest in music (XI) is that one difference is that between *excellent* and *good* on the arbitrary scale of some school and that the other is that between *little* and *moderate* in the mind of some observer. The measures of I, II, III and XII are by *objective* or *impersonal* scales, that is, scales the identification and similar use of which are possible for any competent observer. The measures of VII and XI are by *subjective* or *personal* scales, which another observer could not identify[1] or use in the way in which the

TABLE XXI

Measurements of Three Individuals, A, B, and C

	A	B	C
I. Stature	160 cm.	140 cm.	130 cm.
II. Simple reaction-time to sound	.175 sec.	.125 sec.	.150 sec.
III. Average error in drawing a line to equal a 100 mm. line	3.2 mm.	2.8 mm.	2.2 mm.
IV. Number of words (of a list of 12, heard at a rate of 1 per second) remembered long enough to write them immediately after the last word was read	6 words	9 words	7 words
V. Number of examples in addition (each of 10 numbers, repeating no number in any one example, taken at random from the numbers 10 to 99) done correctly in 8 minutes	14	12	18
VI. Quality, or merit, or goodness of handwriting*			
VII. School marks in history	Ex.	Good	Poor
VIII. School marks in spelling	82	62	93
IX. Efficiency in perception; the number of A's marked in 60 seconds on a sheet containing 100 A's mixed with 400 other capital letters	48 A's	60 A's	82 A's
X. Criminality: number of times convicted of a penal offense	0	1	0
XI. Degree of interest in music	little	moderate	a great deal
XII. Age in days	5,080 d.	6,150 d.	5,615 d.

* As judged from actual samples of their handwriting. These are compared with a standardized scale—such as that of Thorndike.

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[1] If, for example, the reader had heard the oral work and seen the written work which in combination meant *good* in the school whence A and B came, he would not know that they did mean *good*.

person giving the marks used them. Moreover, whatever the scales in VII and XI really are, they are certainly very coarse; a wide range of difference is expressed in them by a few steps or marks or values. In short, any competent thinker knows exactly what is meant by 160 cm. and by 160 cm.–140 cm., whereas he cannot be sure what is meant by *excellent*, or by the difference between *excellent* and *good*.

Concerning the other measurements the following statements are roughly true:—

A, B and C are measured objectively in the quality of handwriting. We know what is meant by the difference between A and B. It is just the difference between the qualities of the two samples presented. But they are not measured conveniently; the differences are not referred to any commonly known scale.

The measurement in addition is nearly objective. If the conditions of the test are defined by a statement of how the examples were presented (what type they were printed in, how they were arranged, etc.), how the answers were given, at what time, under what distractions, with what incentives, etc., they were done, and the like, they become still more fully objective.

In the case of memory, not only the conditions of the test, as in addition, but also the exact words used need to be specified. A differed from B by writing down three less words of a certain list. The list needs to be known if all competent observers are to think of the same thing by *three words.*

The measure of criminality is inferior to the measurement of stature or age by using an ambiguous unit (*convicted of a penal offense*) and also by measuring only very coarse differences. A and C are not differentiated by the measures, though A might just fall short of crime and C be a very healthy-minded and kind-hearted boy.

The measurement of ability in spelling might turn out to be, were the conditions of the test and the system of scoring results in it known, as objective as that in addition, or, on the other hand, may be only a record of the opinion of some teacher that A was a good deal better than B and that C was somewhat above A. As the record stands the $A-B=20$ may mean no more than "*A is good; B is unsatisfactory*," or "*A is somewhat better than B in my opinion.*"

The value $\frac{A-B}{A-C}$, $\frac{B-C}{A-C}$ and $\frac{A-B}{B-C}$ are determinable in the case of I, II, III and XII of Table XXI. In stature $A-B=20$ cm., $A-C=30$

cm. and $\frac{A-B}{A-C}=.667$. When one says that A differs from C in stature one and a half times as much as from B, any competent person knows exactly what is meant. For VII on the contrary we have $\frac{A-B}{A-C}$ $=\frac{\text{Excellent}-\text{Good}}{\text{Excellent}-\text{Poor},}$ which may be a true, but remains a mystical, answer, until *excellent*, *good* and *poor* are defined on some scale.

In the case of the memory of words ($A=6$, $B=9$, $C=7$) $\frac{B-A}{C-A}=3$ and $\frac{B-C}{C-A}=2$, if *to remember any one word = to remember any other one word.* Suppose, however, that the series of words was: "*career, dilatory, opium, never, soap, numbers, add, subtract, one, two, three, four,*" and that A remembered the last 6, C the last 7, and B these and the first two. It would be very risky to assume that the difference between A and B (remembering *career, dilatory* and *numbers*) was only three times the difference between A and C (remembering *numbers*). And it would be almost certain that a difference of $10-4$ in the test would be really more than twice as great as a difference of $7-4$. Under the circumstances *numbers, add* and *subtract* are probably much easier to remember than *career, dilatory* and *opium.*

In the case of centimeters or seconds every competent person knows not only what fact is meant by any given number of the units, but also that *any one unit is equal to any other one, any two to any other two, and so on.* In the case of words remembered, units called by the same name may not be really equal.

In the case of the addition, one example differed from another in difficulty only by chance and only slightly, for when 10 two-place numbers are picked by chance and arranged in a chance order, the chances are enormously against getting any very easy examples like (*a*) or any very hard examples like (*b*).

(*a*)	(*b*)
25	89
35	95
30	58
40	67
60	79
—	—

The chances are still more against getting two or three examples in succession that are on the average more than a trifle harder than any other succession of two or three. Reliance upon the truth of $\frac{A-B}{C-B}=\frac{2}{6}$ however, would be safer if 10, 20, 30, etc., and 11, 21, 31, etc., had been excluded from the numbers used in the tests.

In the case of merit of handwriting, the differences between A and B, B and C, and A and C do not even pretend to be put in terms so as to allow comparison. As the records stand, any one must get the differences transposed into terms of some unit before he can calculate $\frac{A-B}{A-C}$ at all. Since the measures of A, B and C are objective, this can be done. If, for example, the measurer could show that the difference between A and C was approximately five-twelfths of the difference between two standard samples accessible to all competent persons, and that the difference between A and B was approximately two-twelfths of the difference between the same two standard samples, he could then regard $\frac{A-B}{A-C}$ as, of course, $\frac{-2/12\,k}{-/-12\,k}$ or $\frac{2}{5}$, k being the difference between the two standard samples.

The sum and substance of these pages is that a measurement of human nature to be useful for our purpose must identify the *amount* in question for any competent thinker, just as a useful description must *identify* the *object* in question. To do this it must be objective, that is, free from individual caprice, so that any competent person making the same measurement would get the same result.[1]

It should also, if possible, so state the amount in question that other amounts of the same thing may be compared with it as so much greater or less, permitting differences between the amounts to be expressed in ratios. In still briefer terms, the measurements should be *at defined points on an objective scale, the distances of these points one from another being also defined.*

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[1] Not, of course, exactly the same. There is a personal equation in even the most objective measures, such as the length of this line ———. If they measured it to thousandths of a millimeter, competent observers would not get the same result, except by chance. Nor would the same observer in several independent measurements. The ultimate distinction between objective and subjective is simply that in the former sort of measurements competent observers use very nearly the same criteria and, tho independent, agree very closely, whereas in the latter they use very different criteria and, if independent, agree only roughly. The reader may safely postpone any subtle or thoroughgoing treatment of the distinction until he can study the theory of mental measurements in detail. For our purposes, objective measures may be defined as measures which competent observers could repeat and verify or reject, and subjective measures as measures which they could not so repeat and verify.

EXERCISE

1. Compare the following pairs of traits in regard to their susceptibility to objective measurement: ability to shoot a gun accurately—ability to shoot a rifle accurately; ability to play football—ability to play golf; ability to paint portraits—ability to solve arithmetical problems; ability to read—ability to write fiction.

4. PSYCHOLOGICAL TESTS

BY FORREST A. KINGSBURY[1]

A psychological test may assume any one of countless forms. Almost any kind of a task may be used for a test, so long as it can be used to give a reliable indication of an individual's ability or to predict with accuracy his future performance. The test may require him to answer a series of questions or solve a number of problems, and his score will be the number he answers correctly. He may be required to sort or arrange or mark a series of objects in specified fashion and we may score him in terms of the time required to perform the task. Or a sample of his work, handwriting, composition, or manual construction, produced under prescribed conditions, may be graded as to its quality by comparison with a graded series of standard samples. Any of these—speed, accuracy, quality, or some combination of them —may serve as the basis on which we measure his performance, and provide the terms in which we express numerically his score.

The principle of the psychological test is, then, to use a sample of one's behavior to indicate his abilities or other tendencies, and hence to predict his probable future behavior. This is indeed the basic principle of any sort of test, psychological or otherwise, measuring a representative sample for the purpose of predicting what other samples are likely to be. The grain buyer does not need to examine each grain in a carload of wheat, nor does the structural engineer need to measure the strength of every beam that goes into a building. Having assured himself that the sample of grain or the single beam is typical of the rest, he grades or tests that sample and pins his faith to the uniformity and constancy of the conditions which produced those results. Similarly, when we give a typing test, a cancellation test, or an intelligence test to an individual, we assume that the internal conditions which determined his score on the sample are so constant that we can rely on his doing likewise under any similar conditions. The test then is given *for purposes of prediction.*

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[1] From *op. cit.*, pp. 251–81.

Functional Classification of Tests

While other possible classifications of tests might be suggested, we shall mention only one, for many purposes the most suggestive. This is in terms of the kinds of ability or tendency the tests attempt to measure.

1. Tests of proficiencies
    - *a.* Educational tests
    - *b.* Trade tests
2. Tests of aptitudes
    - *a.* General aptitude tests
        - 1) General intelligence tests
        - 2) Mechanical aptitude tests
    - *b.* Special aptitude tests
        - 1) Physical tests
        - 2) Motor tests
        - 3) Sensory tests
        - 4) Tests of other special mental functions
3. Tests of character and temperament traits

With these various classes of tests and the traits they seek to measure, the rest of our discussion will be concerned. As has been pointed out, the characteristics which the tester measures are almost countless in number and variety. Human ability is not a single, unitary thing, but a vast complex of separate abilities. We cannot hope to get at all aspects of human ability by a single test. We can measure only one phase at a time. To get at every phase would necessitate more kinds of tests than have yet been devised. Some of these phases we designate as *proficiencies* of various kinds; others as *aptitudes;* still others, for want of a better term, we loosely call *traits of character, temperament, personality.*

When we speak of *proficiencies* we are thinking of items of knowledge and skill in some well-organized field, a trade, or a school subject, which have been acquired through definite training and experience. Ability to write a good business letter, to take and transcribe dictation, to operate a lathe or dynamo, to speak French, and to perform a thousand and one other skilled acts—these are definite proficiencies.

Aptitudes refer to specific human capacities which have not been systematically developed toward definite ends, but the possession of which enables one to acquire with reasonable training the proficiency desired. They are potentialities of proficiency. Most, it is true, have had some casual development in the course of daily life, but not in the form in which we wish to use them. One who has never seen a typewriter may nevertheless be proved, by proper tests, to have superior motor and mental aptitudes for this kind of activity, so that with proper training we know he can acquire a satisfactory typing proficiency. One's particular physical aptitudes, sensory aptitudes, motor aptitudes, intellectual aptitudes, in their countless mutations help to determine what special items of skill and knowledge he can profitably undertake to acquire.

Still other phases of behavior to which we refer variously as habits of character, emotional and temperamental tendencies, volitional qualities, traits of personality, etc., can hardly be classified either as aptitudes or proficiencies, since they indicate not so much abilities to act, as natural or habitual *levels* of acting. A test for honesty, for example, would endeavor to measure not how honest a person *could be* if he tried, but how honest he *habitually* is. The importance of such tests for many purposes, we can readily see, is so great that any successful tests of these phases of behavior would be very useful in a great variety of ways.

A functional classification must be even less rigid than those which have been given before. Often we cannot be sure which of several functions is being measured. Thus, when we think we are measuring "general intelligence," we may really be in part measuring the subject's proficiency in reading the instructions. A moral judgment test is likely to be more a test of intelligence than of morality. A low score on some intellectual test like color-naming or letter-canceling may prove, on further investigation, to be really due to some sensory or motor defect. Sometimes what we are testing varies with the way in which we conduct the test. If we ask a subject to name the colors of several objects it may really be a test of his knowledge of color names instead of a test of his color-sensitivity. Hence, we test color blindness by handing him several skeins of colored yarns, asking him to select those which resemble in color certain standard skeins, and we avoid mentioning color names. It follows, then, that the significance of any test must not be obscured by attaching the wrong name to it, such as color blindness instead of color-naming. Some even go so far as to advocate using no test names which imply particular mental processes.

Tests of Proficiencies—Educational Tests

There are two classes of situations in which we most often demand of individuals the attainment of a certain body of organized knowledge and skill—the school and the trade. Proficiency tests have been in daily use in both these fields ever since teachers began examining their pupils and masters began examining their workmen. But it is only recently that these examinations have been "standardized," so that we can be sure the tests are reasonably valid and results widely comparable.

Today, for amost every elementary and secondary-school subject there are available one or more standardized tests. An idea of their number and scope may be gained from the following list, taken from a recent bibliography[1]: English (Composition, Copying, Grammar and Punctuation, Language, Poetry, Spelling), 48 tests; Mathematics (General, Arithmetic, Algebra, Geometry), 45; Reading, 40; Handwriting, 24; Science (General, Biology, Chemistry, Geography, Physics), 24; Foreign Languages (General, French, German, Latin, Spanish), 17; History (General, American, Ancient), 14; General school-survey tests, 7; Commercial, 5; Drawing, Home Economics, Vocational Subjects and Manual Training, 4 each; Music, Physical Training, 3 each; Citizenship, Journalism, 1 each. While of course such tests are meant primarily for schools, it is readily apparent that many of them may have value for employment purposes, particularly for office jobs.

Test of Proficiencies—Trade Tests

Trade tests have been worked out for special kinds of work in a few industries and for a few standard occupations, such as stenographers, typists, and general office clerks. These are usually standardized samples of the work done in that trade. We must distinguish clearly between these and the special-aptitude tests which will be described later, and which are used for industrial selection. The latter are *not* trade tests, even though they relate to certain trades. The trade test is a test designed to measure not merely the aptitude for acquiring a trade, but the actually learned skill and knowledge involved in that trade. Hence they can be of wide general use only when the specific items of knowledge and skill implied by the test are everywhere uniform, not limited to the practices of a single institution or even a single community.

The most conspicuous achievement in the trade-test field is the group of trade tests devised for the United States Army. During 1918 tests for eighty-three trades were devised and standardized by the Trade Test Division and used in various army camps for selecting those men who had the necessary trade ability—knowledge and skill—necessary in a great military organization. As examples of trades for which such tests were devised may be mentioned auto repairer (general, and four sub-trades), baker and cook, office clerk, five electrician trades, stable boss, twelve machinist and mechanic trades, four printing trades (compositors, cylinder pressman, lithograph pressman, platen pressman), two sheet metal worker trades, telegraph and wireless operator, and many others.

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[1] *Bibliography of Tests for Use in Schools*, Fourth Edition, World Book Company.

These tests were standardized in industrial plants and were designed to be administered and scored by officers who themselves were wholly unfamiliar with the trade in question. They were arranged to reveal four grades of trade ability, novice, apprentice, journeyman, and expert, and were brief enough to meet the demand for economy of time.

Three general types of trade tests were used; (*a*) the oral question test, (*b*) the picture question test, (*c*) the performance test. The first type, which was the most common, comprised questions pertaining to the trade which could be, as a rule, correctly answered in only one way, and by a single word or brief phrase. This permitted scoring each answer unequivocally as "right" or "wrong"—a very important technical detail. Among the fifteen questions in the "bricklayer-general" test occur the following:

Q. What are headers used for in a brick wall?
A. To bind (bond) (tie)..Score 4

Q. What do you call a course of brick laid lengthwise of a wall?
A. Stretchers..Score 4

Q. In setting a sill course how much pitch do you give it?
A. 1/4 to 3/4 inch..Score 4

While the maximum possible score is 60, a score of 53 or above gives expert rating; 44 to 52, journeyman; 13 to 43, apprentice.

In the picture tests, used for cobblers, general carpenters, storage-battery electricians, and others, pictures of tools, processes, objects, or parts were shown and the questions referred specifically to these. In the performance tests—for example, truck driver, inside wireman, steamfitter and others—a representative, though usually brief, task was set, a standard set of tools, materials and instructions were provided, and performance was scored in terms of the quality of the finished product and the time required to complete it.[1]

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[1] J. C. Chapman's *Trade Tests* (Henry Holt & Co.) gives a detailed description of many of these tests as used in the army.

Tests of Aptitudes

The second general division of our functional classification is "tests of aptitudes." Some of these aptitudes are general; others are more specialized. While tests of acquired proficiencies are important, they are far from being the only tests the employer needs to use. A large part of the work done in offices, stores and factories is not of the standardized, skilled-trade type at all. There is often no opportunity to acquire the precise knowledge and skill necessary to do certain kinds of work except within the business establishment itself, either in a vestibule school, by means of some apprenticeship system, or by working under the eye of a fellow-employee or foreman until it is learned. In such cases, instead of proficiency tests, what is needed are *aptitude* tests—tests which will help to pick out those applicants who have the physical, sensory, motor or intellectual aptitudes which will enable them to master the essential operations with a minimum of time and a maximum of efficiency.

Sometimes these aptitudes are rather highly specialized. The abilities necessary for the routine work of an inspector of certain small parts may be accurate and quick co-ordination of particular arm, finger, and eye movements, sufficiently good visual and touch discrimination to detect flaws, and enough brains to understand and remember the simple instructions. But in some other cases the work is not so simple and mechanical. New problems are constantly arising and an employee, to be competent, must be able to "use his head." In such cases, what is most wanted may be a test of general intelligence, by which it will be possible to judge his ability to adjust himself to new situations.

Tests of General Intelligence

Tests of "general intelligence" are also referred to as "general ability tests," "mental alertness tests," or "learning ability tests." For our purposes we may treat these terms as synonymous. They constitute, without doubt, the most conspicuous class of tests at present. So conspicuous are they, and so important, that not infrequently the term general intelligence test is thought of as synonymous with psychological test. But we have said enough to show that they constitute only *one class* of psychological test; and we should not forget that, being only one class, their range of usefulness is definitely limited. Nevertheless, for many purposes it is so important to know the *average level* of one's intellectual abilities that we are warranted in dwelling at some length on them.

The earliest successful intelligence tests were devised by Alfred Binet and are called by his name, although various revisions of the original Binet scale have been produced. To pick out those children in the Paris schools whose general mental development was so delayed as to necessitate their being placed in special schools, he devised the plan of confronting them with a series of simple tasks of graded difficulty. By long experience he found which tasks were within the power of the average 6-year old, the average 7-year old, and so on. These tasks included recognizing and naming simple objects, stating similarities and differences between things, performing three simple commissions given simultaneously, pointing out absurdities in certain statements or omissions in pictures, rearranging disarranged sentences, telling the proper action in given emergencies, and the like. The Stanford Revision,[1] the most widely used American adaptation of the Binet method, provides 6 tests for each year from 3 to 10, 8 tests for year 12, 6 for year 14, 6 for "average adult" and 6 for "superior adult" intelligence.

Now in the language of the Binet scale, the child who can pass the tests equivalent to normal 8-year-old performance is said to have a mental age of 8. If his actual age is 8, he is said to be of normal intelligence, and his intelligence quotient or I.Q. (mental age divided by chronological age, decimal point being omitted) is 100. If, however, he is only 6 but with 8-year-old intelligence, he is described variously as two years mentally advanced, of superior intelligence, bright, of an I.Q. of 133. But if, on the other hand, he has attained this 8-year intelligence level only at 10 years of age, he is termed dull, retarded, of an I.Q. of 80. Such terms are rapidly passing into every-day speech.

But in dealing with adults, we find the mental age and the I.Q. concepts of very limited usefulness; and if those adults are normal—i.e., not feeble-minded or border-line cases—we may well dispense with those terms. In the first place, the tests themselves are inadequate in number and variety for the higher stages—above 12 years—of development. In the second place, these upper age tests have not been so satisfactorily standardized as those for earlier years, since it is harder to round up and test a really average group, in order to get reliable age standards, after they have passed beyond the compulsory school age. So in testing those of high-school age and beyond, and to a large extent in the elementary grades as well, other methods have been evolved. These may be briefly characterized as point-scale group-tests.

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[1] See L. M. Terman, *The Measurement of Intelligence* (Houghton Mifflin Co.).

Group Intelligence Tests

Group tests may possibly be less accurate than individual tests, where the examiner can watch each individual and adapt his manner to the person's emotional attitude. But the greater economy of group tests has led to their wide adoption in schools, employment offices, and other places where it is desirable to be able to test several people in a short time.

The Army Alpha is the prototype of many general intelligence scales which have been devised in the past few years. The bibliography previously mentioned lists no less than sixty-five intelligence scales. Not all these serve the same purpose. Some are for primary-school children, others for high-school or college students, still others primarily for employment purposes. A few are individual, but most are group scales. The National, the Illinois, the various Otis tests the Thurstone, the Thorndike (Columbia college-entrance test), the Terman, the Haggerty, and many other equally well known tests have largely replaced the Alpha scale, although having the same general type of material and organization. The Chicago Group Intelligence Test,[1] which is here reproduced in full, has been extensively used with high-school students, and is typical, both in material and form, of the other scales mentioned.

One modification worth noting is the "self-administering" or "cycle" form of organization, of which the Thurstone and some of the Otis tests are examples. In these the different kinds of test are not separately timed, but are "scrambled," reappearing again and again throughout the test. This makes it easy to administer without error, particularly in the hands of those who are not trained testers since no verbal instructions have to be given and the examiner needs to keep track only of the total time—30 minutes being the usual time allowance. But the intermingling of different kinds of material practically prevents any analytical study of relative performance on different kinds of material within the scale.

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[1] Thanks are due to Professor F. N. Freeman and Dr. H. O. Rugg for permission to reproduce this scale. The time allowances on the five parts are one, three, two two, and one minutes, respectively.

The Chicago Group Intelligence Test

F. N. FREEMAN——H. O. RUGG
University of Chicago

Form B

GENERAL INFORMATION

Your Name...Date.......................................
Are you a boy or girl............ When is your birthday..............................
How old are you............years. Name of your city.....................................
Name of your school... Name of teacher of the class in which you are taking this test.. ....

DO NOT WRITE BELOW THIS LINE

SUMMARY OF RESULTS

Test No.	No. of correct examples	No. of incorrect examples	Score
1			
2			
3			
4			
5			

TOTAL SCORE ____________
Percentile rank (P. R.)..
(i. e. the pupil's rank in a typical group of 100 pupils: Example: A pupil with P. R. of say, 83, is exceeded in mental ability by 17 per cent of the pupils in the same school grade.)

GENERAL DIRECTIONS

Teacher and Class should read these General Directions together. Be sure each pupil understands what is to be done. In this booklet there are five exercises which help to tell how well you can do certain things. You will work one exercise at a time and the teacher will tell you when to begin each one and when to stop. When the teacher says "Begin" turn the page and begin working them exactly in the order in which they are numbered. Work as rapidly as you can but remember that it is important to get the examples right. Try each one but do not spend longer on any one example if you are sure you cannot do it. Do not write anything after you are told to "stop." As soon as you stop working one exercise, the directions will be given for the next one.

Do Not Turn a Page Until You Are Told to Do So

Directions for Exercise No. 1—"Opposites"

One of the three words which is joined to each of the words in the list in Exercise No. 1 expresses a meaning opposite to that of the word at the left of the bracket. For example:

$$\text{Long}\begin{cases}\text{small}\\ \text{low}\\ \text{short }\checkmark\end{cases}$$

"Short" expresses the opposite of the word "long." The other two do not. With each set of words check the word which expresses the opposite meaning.

Now turn to Exercise 1.

EXERCISE No. 1—"OPPOSITES"

1.	up	sloping down level
2.	good	mean bad weak
3.	early	late on time earlier
4.	above	below beside inside
5.	buy	sell keep give away
6	cruel	kind charitable loving
7.	rough	smooth steep soft
8.	stale	clean new fresh
9.	doubtful	confident certain secure
10.	belief	doubt denial hesitancy
11.	to bless	to harm to destroy to curse
12.	forcible	considerate gentle peaceful
13.	intelligent	ignorant illiterate stupid
14.	tender	rough cruel inconsiderate
15.	animated	quiet self controlled sad
16.	silly	learned wise sensible
17.	reckless	careful safe cautious
18.	enthusiastic	uninterested apathetic unemotional
19.	thorough	careless superficial vacillating
20.	ignorant	well informed wise unskillful

(Work No. 11 next—above)

No. attempts .... No. wrong........ No. right........ Score........

This is an example which explains the next exercise.

In each row of numbers below, each number follows the one before it according to a rule. In this series,

7 8 9 10 11 12 13 14

each number is obtained from the one before it by adding 1 to it. Suppose the numbers read

7 8 9 .... 11 12 14

Two numbers are missing. These can be supplied by adding 1 to 9, and 1 to 12, giving

7 8 9 10 11 12 13 14

In the same way the missing numbers in this row,

3 6 9 .... 18 21 33

are 12, 15, and 24, 27, 30.

On the next sheet there are rows of numbers like these from which some numbers are missing. You are to fill in the missing numbers. Remember speed and accuracy are both important.

EXERCISE No. 2—"MISSING STEPS IN THE SERIES"

(A) 1 2 3 4 5 .... 7 8 9 .... 11 12 13

(B) 29 24 .... 14 9 4

(C) 26 22 .... 14 10 2

(D) 64 32 16 1

(E) 1 5 25 .... 625 3125

(F) 486 162 .... 18 6 ....

(G) 7 16 19 28 31 40 .. ..

(H) 3 .... 18 .... 33 53

(I) 72 .... 37 2

(J) 84 .... 54 .... 30 6

No. attempts.......... No. wrong.......... No. right.......... Weighted score..........

Directions for exercise No. 3—"Proverbs"

On the next sheet is given a list of proverbs or sayings arranged in pairs. Some of the pairs have the same or nearly the same meaning. In others, the meaning of one proverb is the opposite of the meaning of the other. In still others the meanings of the two proverbs are not related at all.

Write an S before the pair which means the same or nearly the same; an O before those which have an opposite meaning, and an N before all other pairs.

EXAMPLE: S { (a) One swallow does not make a summer.
(b) One tree does not make a forest.

EXERCISE No. 3—"PROVERBS"

1. .... (a) Shallow brooks are noisy.
(b) Little dogs bark the most.

2. .... (a) Every cloud has a silver lining.
(b) One tree does not make a forest.

3. .... (a) Married in haste, repent at leisure.
(b) Quick loving a woman means quick not loving a woman.

4. .... (a) A man of words and not of deeds is like a garden full of weeds.
(b) Actions speak louder than words.

5. .... (a) Absence makes the heart grow fonder.
(b) Out of sight, out of mind.

6. .... (a) Don't put all your eggs in one basket.
(b) The rat that has but one hole is soon caught.

7 .... (a) Make a virtue of necessity.
(b) Necessity knows no law.

8. .... (a) Silence is golden.
(b) Silence gives consent.

9. .... (a) What you would have well done, do yourself.
(b) Two heads are better than one.

10. .... (a) A penny saved is a penny earned.
(b) A stitch in time saves nine.

No. attempts........ No. wrong........ No. right........ Score........ Weighted score........

Directions for Exercise No. 4—"Analogies"

In each of the lines on the next sheet, the first two words stand in a certain relation to each other. Notice that relation and draw a line under the one word of the five in the parenthesis which has the same relation to the third word as the second has to the first.

SAMPLES
above—top: below—(?) (above, bottom, hang, over, sea)
sky—blue: grass—(?) (grow, dead, green, cut, burned)
cold—heat: ice—(?) (frost, refrigerator, steam, grass, cream)

EXERCISE No. 4—"ANALOGIES"

1. dress—cloth: hat—(?) **(pretty, straw, woman, big, vote)**
2. winter—cold: summer—(?) **(short, dry, hot, long, sea-shore)**
3. above—sky: below (?) **(blue, heavy, level, earth, under)**
4. food—eat: water—(?) **(bucket, desire, drink, pour, sea)**
5. sweet—sugar: sour—(?) **(bread, man, sweet, vinegar, miserly)**
6. skirts—girl: trousers—(?) **(hat, coat, boy, vest, advertisement)**
7. uncle—nephew: aunt—(?) **(brother, cousin, sister, niece, father)**
8. sheep—wolf: mouse—(?) **(fur, cat, kitten, dog, bite)**
9. simple—complex: easy (?) **(brittle, money, hard, work, compound)**
10. anger—violence: love—(?) **(woman, gentleness, child, kiss, sweet)**
11. eat—hungry: drink—(?) **(fish, whisky, water, wine, thirsty)**
12. truth—gentleman: lie—(?) **(live, give, rascal, falsehood, dishonesty)**
13. spoon—soup: fork—(?) **(plate, cup, knife, meat, crackers)**
14. pursue—bold: flee—(?) **(run, afraid, fox, child, bear)**
15. cannon—rifle: big—(?) **(army, small, gun, bullet, bomb)**
16. breeze—cyclone: spring—(?) **(winter, shower, water, bath, flood)**
17. corn—horse: bread—(?) **(flour, daily, butter, man, meal)**
18. eat—mouth: breathe—(?) **(life, air, strangle, nose, foul)**
19. pages—book: twigs—(?) **(tree, wood, branch, leaves, bark)**
20. rafters—house: skeleton—(?) **(skull, body, bones, grace, framework)**

No. attempts........ No. wrong........ No. right........

Directions for Test No. 5—"Selecting Best Reasons"

On the next sheet make a cross before the best answer to each question.

EXERCISE No. 5—"SELECTING BEST REASON"

1. Why are beans good food? Because they
   1. are raised in many states.
   2. are nourishing and economical.
   3. are eaten by many peoples.
   4. look well when served.
2. If the health department says that the drinking water of the city is not pure, what is the thing to do?
   1. drink coffee.
   2. drink only at meal times.
   3. boil the water before using it.
   4. eat plenty of salt.
3. Why should every house have a fire extinguisher? Because
   1. they are ornamental.
   2. they cost only a little.
   3. they are easily used.
   4. they easily prevent a serious fire.
4. Why should food be chewed before swallowing? Because
   1. it is better for one's health.
   2. it is good for the teeth.
   3. it is better manners.
   4. solid foods are wholesome.
5. If you fall asleep on the train and ride past your station, should you
   1. pull the bell rope and stop the train instantly?
   2. tell the conductor to take you back?
   3. get off at the next stop and take another train back to your station?
   4. jump off and walk back?
6. Why is gold more costly than lead? Because
   1. it is of finer appearance.
   2. it is more scarce.
   3. it is used more for jewelry.
   4. it is yellow.
7. Why judge a man by what he does rather than by what he says? Because
   1. it is wrong to tell a lie.
   2. a deaf man cannot hear what is said.
   3. it is wrong to judge anybody.
   4. what a man does shows what he really is.
8. If your opinion were asked of a man whom you didn't know, what would be your reply?
   1. I think he must be a fine man.
   2. I will look him up and get acquainted.
   3. I don't know and can't say.
   4. I doubt his ability.
9. When you have a hard task to perform, should you?
   1. leave it until tomorrow and you may not have to do it?
   2. leave it to the other fellow?
   3. get to work on it at once?
   4. think out the best plan; then go to work?
10. If you should sprain your ankle while on a hiking trip, what should you do?
    1. lie down under a nearby tree?
    2. shout to attract attention?
    3. take a drink from your water bottle?
    4. ask someone to send an ambulance?

No. attempts.......... No. wrong.......... No. right.......... Weighted score..........

Tests for Illiterates

The problem of testing the intelligence of illiterates is met by using one or more of several kinds of performance tests. Some of these are individual tests, while others can be used as group tests. Among these may be mentioned the following: Form-boards of various sorts, in which variously shaped blocks are to be fitted into a frame or placed in similarly shaped holes in a board; dissected picture puzzles of various types; arranging a series of pictures in such order that they tell a connected story; completing imperfect pictures, as for example a face lacking a nose; mazes, through which the subject has to find and trace the shortest correct path. Many other tests requiring no ability to read or write have been devised. The Beta group test used in the army for testing illiterates included seven such tests arranged in pictorial or other non-verbal form, printed in a booklet, the directions being given in pantomime and the responses made by marking or checking, or at most by copying single letters or figures. Of this same type are numerous pictorial group tests for primary school pupils who have not yet mastered reading skill.

Some psychologists assert that we should distinguish at least three broad classes of "general intelligence," the abstract or verbal, the mechanical, and the social types, with many subvarieties under each; and that the kind of general ability most of the present general intelligence tests measure is only one class, ability to deal with verbal material and abstract thinking. There can be no doubt of the great importance of this kind of intelligence; but it would be a mistake to think that it is the only kind that counts. Many people who would score low on the Alpha show a high degree of ability to deal quickly and competently with problems involving tools, or mechanical or manual operations, even problems entirely novel.

Tests of General Mechanical Aptitude

The Stenquist mechanical aptitude and assembling tests are good examples of tests for getting at this general ability. The assembling test consists of a series of small mechanical objects taken apart—a bicycle bell, a paper-clip, a cheap lock, a clip clothes-pin, a mouse-trap, a cupboard-catch, and other articles, which the individual is instructed to put together correctly as rapidly as possible. His performance is scored both in terms of accuracy and time. The mechanical aptitude test is printed so that it can be given as a group test. Pictures of mechanical devices, tools, and the like are shown and the subject indicates by letters and other marks the objects or parts which belong together.

While all these tests involve more or less experience and training and hence are definitely tests of acquired ability, that ability is of a general mechanical sort rather than pertaining to any specific occupation, and is to a large extent such as one of a mechanical turn of mind is likely to pick up for himself outside a trade school. They are, therefore, tests for aptitude and not trade tests.

Tests of Special Aptitudes

In contrast to the general aptitudes we have been describing, those of the next class, the "special aptitudes," are so many and so varied that it is impossible to reduce them to elements or classes. Hence we can do little more than to enumerate and describe some of those in most common use. The best known authority on such tests is G. M. Whipple's *Manual of Mental and Physical Tests* (Warwick & York), although far from all of the useful tests are described therein. We have suggested that these tests may be crudely classified as physical, motor, sensory, and intellectual, or "mental" in the narrower sense, and this order will serve to orient us in our discussion.

Physical tests are not, of course, strictly speaking, the psychologist's business. But anyone who has worked with tests knows how impossible it is to draw fine distinctions between "physical" and "mental." A test of endurance of hand-grip may test will as much as muscle. But, leaving aside such hair-splitting issues, the psychologist does often have to know a great deal about traits which are definitely physical in order to supplement and interpret his other tests. Height, weight, skull diameter and capacity, breathing capacity, chest expansion, strength of grip, endurance of grip and a dozen other body measurements are a necessary part of any complete series of tests whether for educational, clinical, or vocational purposes, and every tester is likely to have to make them. To some degree this is also true of the more strictly medical tests.

Tests of *motor* aptitudes play an important rôle in many industries. Tests for quickness and accuracy of movement, of muscular co-ordination and control, appear in the test literature in a variety of forms. Quickness of movement may be tested, for example, by tapping with a metal stylus on a metal plate, both arranged in an electric circuit with an electric counter which counts the number of taps in a given period. One kind of bodily control is measured by standing the blindfolded subject beneath a horizontal, inverted, smoked-paper surface upon which a vertical pointer, fastened to his head, traces his involuntary movements. Other motor tests have been specially devised to duplicate as closely as possible the conditions under which specific manual work is to be done.

Sensory tests are of many sorts, and most are well known. They include tests for optical defects—errors of refraction, convergence, etc., as made by the optometrist with an ophthalmoscope or vision chart and lenses, and which are necessary where perfect eyesight or perfectly fitted glasses are essential; tests of color blindness for occupations like railroading or navigation; watch-tick or whisper tests for acuity of hearing; tests for sense of pitch with tuning forks of slightly different vibration rates, or with special phonograph records; tests of other musical capacities, such as those devised by Seashore,[1] some of which are available on phonograph records, others requiring special apparatus. (Tests for the sense of equilibrium and the perception of slight movements, by whirling or tilting the subject and observing his verbal or pointing responses, have been tried in aviation.)

Tests for Special Mental Aptitudes

Tests of the simpler mental functions are among the oldest we have. They vary from the simpler "attention" and "perception" tests, up through the "memory," "association," and "imagination" tests, to the tests of "judgment" and "higher mental processes." Strictly speaking, none of these is a test of single or even of simple processes; their simplicity is at most relative. Probably it is of very little practical importance for the tester to know just how to classify or name them. It is more important to know something of their scope and nature, and to find, by experiment, how closely ability in each of them correlates with the abilities we want to measure.

As examples of tests which have found a place in industry, we may mention the following: The cancellation test; in this the subject is required to cross out each *A* or other letter or letters in a page of printed capitals in the shortest possible time. Sorting tests of various kinds

CANCELLATION TEST

KDFLHAZLPSHUEBDARSBENXRDBAPVKEAXZAF
LBPRENFABDXLSERAZUABKEHMRSZBALPTHDE
AMKFZCEBUASPORDPHRKBNVEASBAUTDMXHES
HNRSPEZKDNBFAGLCEKBSDTRNEOKGBVADABR

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[1] C. E. Seashore, *Psychology of Musical Talent*, (Silver Burdette & Co.).

may involve sorting cards, although they may use instead the special materials with which the job deals. Memory-span tests measure the number of letters, digits, or unrelated words one can remember and repeat after hearing them once. These have been suggested as useful for telephone operators and for stenographers. Substitution tests, in which a series of digits are to be substituted for corresponding letters according to a prescribed code, have been used by some investigators for testing typing proficiency. Many of the separate tests which appear as parts of various general intelligence tests may be used separately for testing more limited mental functions. There are literally scores of other special mental ability tests, which we cannot here even enumerate, but which get at one or another of a variety of traits of vocational importance.[1]

A number of tests have been devised by various investigators specifically for some particular occupation. Such, among others, is the apparatus devised by Münsterberg and described in his *Psychology and Industrial Efficiency* for testing street-car motormen, or Link's modification of the Bogardus fatigue apparatus, for testing machine operators. These cannot be classified as "mental tests" in the strictest sense, since they involve sensory and motor aptitudes as well as intellectual. But they are "special" rather than "general" because each has been devised to fit a single occupation.

Tests of Character, Temperamental, and Volitional Traits

Among the newer psychological tests are those for the many distinguishable volitional, temperamental, emotional and character traits. These have not yet passed beyond the experimental stage. One of the best known is the Downey will-temperament test, available both in individual and group form. It uses chiefly modifications in the speed and form of handwriting as its material. It is designed to measure several temperamental or volitional traits, to which the following names have been given: speed of movement, freedom from load (tendency to work continuously at maximum speed), flexibility, speed of decision, motor impulsion, reaction to contradiction, resistance to opposition, finality of judgment, motor inhibition, interest in detail, co-ordination of impulses, volitional perseveration.

Recent activities of many other workers in devising tests of such traits indicates the interest in this inadequately analyzed aspect of personality. Tests of such instinctive and emotional traits as susceptibility to anger or fear, or of such volitional traits as aggressiveness and perseverance, have been described in psychological periodicals, but they have not been sufficiently standardized to warrant description.

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[1] H. C. Link, in the appendix to his *Employment Psychology* (Macmillan), describes a number of these tests which he found useful.

Several tests of "moral judgment" have been proposed, such as a series of hypothetical acts which the subject is required to rank in order of relative merit or demerit. These have been used to some extent among delinquents and defectives, and reveal the frequent lack of ability on the part of these unfortunates to estimate correctly even the more obvious moral values. But "circumstances alter cases"; and moreover even the ablest judges will not always agree on which of two sins is the more heinous, or on which of two acts is the more praiseworthy. Hence such tests on any advanced scale have very doubtful value.

But what is more important, moral *judgment* is only one factor in morality. Most people *know* better than they *do*. An intelligent criminal could doubtless make a perfect score in a test, telling what should or should not be done in certain situations, providing he thought he had anything to gain by passing such a test. To know what, according to common standards, ought to be done is no guarantee that one will have the habit of doing so or the desire to do so. The Voelker tests of habits of moral trustworthiness used in studying moral education among boy scouts have shown that there is a possibility of character tests. These tests set up critical situations to find whether the boy succeeds or fails in conforming his conduct to the accepted standards of honesty, punctuality, faithfulness, and the like. The success of such tests rests wholly upon the subject's not knowing that he is being tested. This condition it is rarely possible to achieve.

There is another phase of social personality, however, more easily examined, and that is the range of one's interests. A common method is to provide a series of questions, each with alternative answers to be checked, or else statements some of which are true and some false, to be correctly indicated, and pertaining to a wide range of human interests. This method assumes, probably with justification, that the range and character of a man's knowledge is an index of the range and character of his interests. If one answers correctly every question about baseball, fishing, and poker, and misses most of those about religion and literature, it indicates at least something about him. One test of this type asks fifty questions about such diverse recreational interests as popular songs, sports and games, underworld slang, etc., and is said to be useful for selecting salesmen for work where wide and ready social adaptability to men of various classes is necessary.

It will be evident by now that the field of psychological tests is one capable of indefinite, almost infinite, expansion; for only a comparatively few representative samples have here been mentioned. Some of these have proved their worth for occupational selection in various lines; others may yet do so. One who endeavors to select tests for a given occupation finds at hand many ready-made standard tests and his principal task may be to find out whether these tests do really serve to distinguish good from poor workers. If he cannot find ready-made tests to meet his needs, his first task is to devise and standardize tests which he thinks will be worth trying out. But in any case his problem is not solved until such tests have been actually tried out on workers of known ability and the value of the tests for the specific purpose in mind scientifically determined.

EXERCISE

1. What would be some of the difficulties of testing native aptitudes absolutely independent of acquired proficiencies?

5. THE TESTING OF PSYCHOLOGICAL TESTS[1]

BY ARTHUR W. KORNHAUSER

Not all psychological tests are good. Some of them are worse than useless. The mere fact that tests are used in a given situation does not mean that results of demonstrated value are being achieved. Any one can make a test, and any one can use tests. The process is simplicity itself. One merely asks some questions, or brings together some puzzles, or instructs the person tested to perform some acts—acts that are foolish or sensible, depending upon the temperament and ingenuity of the test-builder. But with the statement that it is easy to construct tests, and that it is easy to give tests, let us always link the even more significant statement that there are bad psychological tests as well as good psychological tests.

Constructing tests and constructing *effective* tests are not identical. Using tests on faith is a very different process from using tests on the basis of their demonstrated value. Here, precisely, is the significance of the entire technique of test-building and test-standardization. The problem is in part the devising or choosing of tests that appear promising, but the decidedly more important part of the task consists of "testing the tests," that is, of ascertaining just how well each test works. If it were possible to tell by looking at tests which ones would prove satisfactory, and which would not, there would obviously be no need of careful methods for determining their relative merits. But experience has demonstrated that the description of a test reveals little concerning its value. The one safe method by which to judge the excellence of a test is to try it. A priori opinions regarding tests have been repeatedly contradicted by later results. So true is this, in fact, that scientific workers in the field frequently begin their search for a useful test by trying a rather large number of different tests in the confident expectation that many of those tried will prove unfit and be rejected. But these weak links cannot be detected and eliminated in advance. Recourse must be had to experiment. It is necessary to test the tests.

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[1] "Scientific Method in Constructing Psychological Tests for Business," *Journal of Political Economy*, XXI, 401–32.

It follows quite reasonably that if one is to form sound judgments about psychological tests, it is more important to understand the technique of evaluating tests than to be familiar with particular sorts of tests or to know what the tests are alleged to be measuring. The real question about a psychological test is: Does it work? That question implies that there is a definite purpose for which the test is desired, and that the success with which that purpose is satisfied is, in the final analysis, the only basis on which the value of the test can be estimated. Ordinarily, the purpose is clear—the test is to aid in selecting people with respect to their ability for some particular line of work or course of training. The excellence of the test in fulfilling that purpose is the thing to be determined. *Does the test enable us to make predictions as to people's fitness for the job in an appreciably better, cheaper, or more expeditious manner than can be made without the test?* If it does, it is a successful test; if not, it is unsuccessful.

The most straightforward procedure for ascertaining the "success" of a test can be very briefly stated: The test is given to a number of individuals whose ability in the job is already known or can later be determined. If test scores agree sufficiently closely with the *known* ability of the persons tested, the test is in so far satisfactory. It can then be used to predict the ability of *unknown* persons of the same general group as those upon whom it has been tried. Clearly, however, this bare statement needs a great deal of amplifying and qualification. Whether or not a test "works" is to be answered only after careful experimental investigation along the lines just indicated. Above all other considerations in the test field is to be emphasized the necessity for experiment, and more experiment, for usually it is only by the rigorous experimental testing of test results that we can distinguish good tests from poor tests.

Before we proceed to discuss the actual steps in the construction and standardizing of tests, it is to be noted that there are a few tests, the value of which has already been definitely established through many experimental tryouts. Where an occupation is highly standardized, and uniform from one business establishment to another, it is often possible to infer that a test which operated successfully in the one will, without necessity of further proof, prove satisfactory in the other. Thus a test for typists once it has been carefully prepared and verified in several companies, may be widely adopted by other companies, provided reasonable precautions are observed in administering the test and interpreting the scores.

There are comparatively few of these ready-to-use tests available, however. Even with fool-proof intelligence tests, and tests of trade proficiency, the purposes for which the tests are used and the conditions of their administration are likely to differ so markedly from place to place that experimental tryouts are indispensable. It has been found, for example, that the level of mental alertness of office boys and clerks in one office may require the use of very different standards from those in use in some other office. It has been found that tests which were successfully used in selecting shell and cartridge inspectors were almost worthless in selecting workers for the allied occupation of gauging shells. It has been found that intelligence tests which proved worthless when used with certain groups of factory workers were decidedly valuable in another factory. Trade tests which gave good results in the army have failed to work in certain industrial situations. All such results that are available point to the same conclusion. The same test will give the same results only in case the conditions and purpose governing its use are closely similar. And it is usually impossible to know that the situations are sufficiently similar except by trying out the test anew to see whether it does give useful results.

The fact remains, nevertheless, that some few tests for certain widely standardized occupations have been tried in so many places and under so many different conditions that it is now possible to use them as generally applicable tests for those occupations. This is true, for example, of occupations such as typist and stenographer, and a number of the manual trades. It is also true of a wide variety of unstandardized occupations where "general intelligence" or mental alertness and abstract thinking ability are important requirements. Thus general intelligence tests have been used to indicate the alertness of clerical workers, salesmen, office boys, and so on, just as they were used for testing men in the army and are used for testing children in the schools. Wherever these standardized tests are put into immediate use without special tryout, however, it is a wise policy to keep careful records of results, and to check back, as soon as this can conveniently be done, to ascertain precisely how valuable the results are *in this new situation.*

We have emphasized that these ready-made tests are frequently exceedingly valuable. But they are just as valuable as experiment has shown them to be, and not more so. To judge of that value, it is essential that one know the technique of test construction and tryout. In the case of home-made tests, it is even more important. The administrative use of tests is justified only after adequate experimental proof has been obtained that in this particular situation and with these particular tests, successful results are attainable. To the steps in the making and standardizing of tests, we accordingly turn our attention.

FUNDAMENTALS OF TEST CONSTRUCTION AND STANDARDIZATION

1. *Know the requirements of the job.*—Some knowledge of the work for which people are to be selected is essential. If one is to devise a test for drill press operators, or type setters, or shipping clerks, he needs to know with considerable intimacy what is done by individuals in each of these occupations. The tests which are to be experimented with can be chosen only on the basis of some more or less plausible relationship between particular tests and the sort of duties performed in the job to be filled.

2. *Choose or devise tests to be tried out.*—After the test technician has become sufficiently acquainted with the work for which men are to be selected, his next task is to decide upon tests that appear to be promising for the specific purpose at hand. Frequently there are tests already available which have been used elsewhere for similar occupations or which appear for some other reason to be promising candidates for election as successful tests. At other times, the psychologist finds no tests already in use which are quite the sort he desires, and in that case he may devise new ones. In this matter of choosing and devising tests, we can readily appreciate the importance both of a wide knowl-

edge of tests and test results, and of ingenuity in planning new devices or variations of old ones. As was earlier mentioned, the expert in seeking tests for a job is usually not able with any assurance to state in advance which test, or even which kind of test will prove successful, though this is not true of certain of the occupations where tests have been widely standardized. The typical procedure, accordingly, is to begin the experiment with a number of tests. Some will early be eliminated; others are likely to give results sufficiently valuable to justify their retention and use. Clearly the expense and the success or failure of building tests depend largely upon the wise initial selection of tests to be tried. The office manager who tried out as a test for bookkeepers problems in extracting cube root and solving algebraic equations was pretty definitely foredoomed to failure. Even clever guesses as to good tests, however, are worthless unless combined with a thoroughgoing, experimental and statistical check to *prove* the wisdom of the choice.

3. *Obtain the scores made on the selected tests by individuals whose ability in the job is ascertainable.*—Once the tests to be tried are decided upon, the way to find whether they "work" is to try them out and "see what happens." The way in which the tests are administered and all other conditions affecting test results must duplicate, as nearly as possible, the conditions under which it is proposed to use the tests. Hence, typically the best procedure is to try the tests on all the applicants who are considered for the given job, just as they would be used in regular employment procedure. A less desirable method, but the one which for practical reasons is most used, is to try the tests on workers already employed in the occupation. The important thing is to have the conditions of the try-out and the kind of people who are tested, as similar as possible to the conditions and people that will be involved in the final use of the tests. The number of persons for the experimental try-out must be sufficiently great to insure their being truly representative of the general run of applicants for that occupation, or of the general run of workers in the occupation, if the test is being tried out on men already employed.

4. *Obtain some measure of the ability on the job of the individuals who were tested.*—In order to judge how well the tests indicate the abilities of workers, it is necessary to secure definite information as to the amount of ability possessed at the given kind of work by each of these men. There are two principal sources of this information which is

to constitute the criterion against which test scores will be checked. In the first place, production records are available for many lines of work, which show the exact output of each individual worker. These may frequently be used directly as the measure of individual efficiency on the job. For very many occupations, however, individual production records are not obtainable, or are not an adequate measure of competence. In these instances, a second sort of criterion is used, namely, estimates of the worker's ability at his job by the executive under whom he works. These personal opinions have many shortcomings and grave inaccuracies, but when properly safe-guarded, and obtained from several executives independently, they prove at least tolerably satisfactory.

Another criterion of an entirely different kind is sometimes added to production records and ratings by superior executives. It is the record of the length of time the individual employees remain on the job. Clearly, it is important to ascertain whether men with high or low test scores show a higher rate of turnover than do those with less high or low scores. This criterion is almost always to be used in conjunction with the measure of ability supplied in supervisors' ratings or production records.

5. *Determine the agreement existing between test scores and ability on the job.*—The two preceding steps are significant only as they are utilized for purposes of careful statistical comparison. The logic of the situation is simple. If the men with high test scores prove to be the men with high production records or supervisors' ratings, and the men with low test scores prove to be the workers who fail to make good, then to the degree that this agreement holds true, the test is successful. The inference is, of course, that if the test shows successfully the ability of the individuals in the group upon whom it is used experimentally, it will be similarly useful in predicting the ability of any unknown applicant. The usual statistical method for ascertaining the closeness of the relationship is called "correlation," and the numerical index of the relationship is a "correlation coefficient." If there is considerable agreement, the correlation coefficient is high; if very little agreement, the correlation coefficient is low. The excellence of a particular test may, then, roughly be said to be indicated by the size of the correlation. In everyday language, this is nothing more than the statement that the value of a test is shown by seeing how well it picks out good workers and poor workers. Often it is possible to make such comparisons more effectively by simple statements such as:

Of all workers scoring below 138 on this test, 92% failed to make good on the job, while above that score, only 20% failed at the work.

Correlation coefficients and percentage comparisons do not automatically tell whether the test is a good one to use. That decision must depend upon other facts as well, one of which is the degree of success of alternative methods of selection for this job. If, for example, the years of schooling of the applicants show the same relationship to their ability at the work as do the test scores, it may not be worth while using the tests. It will not be worth while, that is, unless the tests and years of schooling combined work appreciably better as a basis for prediction than does the amount of schooling taken alone.

6. *Set test standards for the acceptance, rejection, or classification of applicants.*—If some of the tests tried out experimentally give sufficiently good results to warrant their further use, it is then necessary to set standards or "critical scores." For example, a score is specified at such a point that applicants scoring below this are not to be accepted for the job unless they have special compensating qualifications or a score may be set at a point where it is possible to say that applicants scoring above this are to be given specially favorable consideration for employment; or several ranges of scores may be indicated which will divide candidates into classes according to their ability. All these standards are set on the basis of the scores actually made by individuals of known ability.

EXERCISE

1. Can you explain why a test which selects "good" plumbers for the army may not do so for a civilian concern? Can you explain why a test which selects "good" clerks for one office may not do so for another?

6. MENTAL ORGANIZATION[1]

BY HERBERT WOODROW

The Problem of the Interrelationship of Mental Traits.—The brightness of a child does not depend upon his ability in any one respect. A child is by no means of superior intelligence simply because he can draw well, or because he is good at rolling a hoop or playing marbles or even because he can learn his multiplication table with exceptionally little study. ~~As~~ repeatedly ~~pointed~~ out, intelligence is the capacity for success in performances in general. It includes all the capacities for the hundreds and thousands of different things which a human being can do. As soon as this is admitted, the question at once arises: Are all these hundreds and thousands of capacities separate? Do they vary so independently of each other that the degree of perfection of one is in no way an index to the degree of perfection of the others?

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[1] Adapted from *Brightness and Dullness in Children*, pp. 213–22. Philadelphia: J. B. Lippincott Co., 1919.

I know of no writer so extreme as to insist that there is utter lack of relationship between the different performances of which a human being is capable. It is true that Thorndike, one of the world's most eminent educational psychologists, has been accused of taking this stand. Binet writes that, according to Thorndike, the mind is a vast multitude of absolutely unlike faculties, existing side by side, but remaining rigorously independent. Binet's citation, however, somewhat exaggerates Thorndike's views. A more just conception of his position is given by the following quotation: "Almost any, if not any, one thing in the mind may happen in partial independence of almost any, if not any, other thing." However, it can hardly be denied that Thorndike at times approaches something very near an atomistic theory of mind, a theory, that is, that mind is merely a collection of a vast number of extremely minute functions, each of which is complete in itself, although united to others by more or less mysterious "bonds." As atoms, he uses a miscellaneous assortment of feelings, acts, "connections," "capacities" and "abilities." This opinion considers mind to be merely an agglomeration or "sum total" of "an individual's feelings and acts, of the connections between outside events and his responses thereto, and of the possibilities of having such feelings, acts, and connections." He holds that "the mind is a host of highly particularized and independent abilities"; and emphasizes the independence of these innumerable mental processes. Even so, Thorndike is far from believing that there is no relationship or interdependence between the innumerable specific mental acts. Indeed, all authors have admitted some sort of interrelationship of mental processes, some degree of mental organization or unity of mind; and it is here the problem to discuss the nature of this organization.

Three Psychological Theories of Mental Organization.—The problem has had a long and devious history which is worth briefly reviewing. Early psychology assumed that mental processes were largely manifestations of the activities of the soul. Starting with the distinction made by Aristotle between the "rational" soul and the "animal" soul, philosophers finally arrived at the classical triple distinction of the three faculties of knowing, feeling, and willing. Each of these was a manner of performing, a mode of activity, possessed by the soul. Whenever one experienced an emotion, his soul was exerting its faculty for feeling, and whenever one perceived anything, its faculty for knowledge, sometimes called the faculty of cognition or intellect. Of course all such explanations of mental processes as faculties of the soul were unsound and futile. Very largely, however, they seem to have been intended to describe the mind, to state the different kinds of things the mind does. The three great faculties of knowing, feeling and willing were soon subdivided into many subordinate ones, until finally the number of subfaculties was quite large.

The classical doctrine of the three faculties meant simply this: First, that every mental act could be classified under one of these three headings—intellect, feeling, and will; second, that all the acts included under any one of these headings were due to the activity of a single factor. Thus every act of perceiving or judging was to some extent due to the functioning of one faculty or capacity. The ancient view of this faculty as a capacity of the soul has no significance; the fundamental thought is little modified if we substitute *brain* for *soul;* because the crucial idea is merely that all similar mental acts derive their characteristics in part, though not entirely, from a single, unitary factor, from one condition or set of conditions. Thus stated, the faculty psychology contains a germ of truth; that is why it has been "so easy to scotch, but hard to kill."

After a long and flourishing existence, the faculty psychology finally fell into disrepute. Curiously enough, the really serious arguments against it are of two quite opposite sorts and both are tenable. On the one hand, faculty psychology is said to be at fault because it divides the mental life into isolated compartments independent of each other, whereas in reality the mental life is unitary. Man is one, not three. "We do not think and only think in one moment, and will in another, and feel in yet another. There is no experience which is now intellective, now volitional—and at another moment, affective. The unitary experience may not be broken up thus. Any portion of concrete experience, select it by what rule we may, is a thinking—feeling—willing experience."

The other objection to the faculty theory, made by men, who, like Thorndike, emphasize the relative independence of each specific mental act, is that no such thing as a faculty exists, because each act differs from all the others, even when it may be classified under the same heading. It is pointed out that a person may have a good memory for faces with a bad one for names; that he may listen attentively to an orchestral symphony and dream through a lecture on mathematics; that he may reason well in one line of business and poorly in another. There is no faculty of memory as such, these authors say, because one thing may be remembered while another is forgotten. "There is no one memory," writes Thorndike, "to hold in a uniformly tight or loose grip all the experiences of the past. There are only the particular connections between particular mental events and others, sometimes resulting in great surety of revival, sometimes in little."

Here, then, are three distinct psychological theories. The oldest and perhaps the most influential is the doctrine of faculties, the doctrine that certain mental processes are alike in some important respect, and influenced, determined in character, to some extent, by a single factor. Also, there is the doctrine of unity of mental life, which may be carried to the point of excluding any possibility of separate faculties. The third view, extensively advocated at present, is that each mental process is so emphatically unrelated to any other that to regard any large group of mental processes as being controlled by the same factor is misleading. This doctrine contends for mental *disorganization*, and according to it the degree of interrelationship between mental processes of the same class is not sufficient to justify any grouping of them together as dependent upon a single capacity.

The Evidence from Correlations.—A brief account has now been given of three widely divergent views of the mind's mechanism. The first considers mind to be a combination of faculties, or manifestations of faculties; the second regards it as a homogeneous unit, or the manifestation of a unitary soul; the third believes it to be a mosaic of innumerable elementary processes. The first is the multifocal theory; the second, the unifocal; and the third, the non-focal.

For the purpose of judging between the three, psychologists have carefully examined the correlations between different mental traits. Because each theory implies different relationships between mental traits, the determination of these relationships should establish one of the three as correct. The rapid multiplication of mental tests during recent years has been of great service in this connection. These tests measure innumerable traits. Just what relationship between the measurements of these traits is implied by each of the three views of mental organization?

According to the multifocal theory, mental tests of the same general function or faculty should correlate more closely than tests of different faculties. Thus several different memory tests given to a large group of children should correspond more closely with each other than should a memory test with a test of sensory discrimination, reasoning, or attention.

According to the second theory, the non-focal, no correlation at all should appear between any two tests except in so far as they involve identical elements. The fact that one child has a better memory for spoken numbers than another, would not, under this theory, indicate that he has also a better memory for printed numbers. There should, moreover, be no greater correlation between two different memory tests than between a memory test and a test of attention, because in all cases the correlation should be practically zero, if, as the non-focal theory states, all mental traits are unrelated.

According to the third theory, the unifocal, the correlation between different tests is due entirely to some single general factor. Extreme versions of this theory require the correlations between all mental tests to be perfect. Since all mental traits are but manifestations of the working of a unitary mind, according to the unifocal theory, if one child's mind is better than that of another in any one specific trait, it should be correspondingly better in every other. The different theories of the mind's constitution thus imply different degrees of correspondence or correlation between the various mental traits; consequently, it is by the study of correlations that they must be compared.

The correlations first obtained seemed to support the non-focal theory. They were so low in most cases as to suggest little or no correspondence between any two mental abilities. Thus, Wissler who published the results of the tests given for many years to the freshmen of Columbia University, came to the conclusion that although the markings of students in college classes correlate with each other to a considerable degree, they do not bear out the mental tests, nor do the mental tests show much correlation with each other.

To a considerable extent the correlations found at first were low because of inaccurate measurements and inadequate statistical methods. Even from the first, however, the correlations obtained were far from being as low as the non-focal theory demanded. With improvement in tests, in the manner of giving them and in the statistical methods of calculating the correlations, it has gradually become established that even quite dissimilar tests may show a very decided correlation. With a large group of individuals, *some* degree of correspondence appears between their rankings in one test and in any other test. Plainly, mental abilities are related. At the same time, no two tests give results that correspond perfectly; so that while mental abilities are related, they are partially independent.

EXERCISE

1. Name some abilities that you believe are closely related; some that are not closely related. Can you explain the difference between the closely related and the less closely related abilities?

7. THE CRITERIA OF INHERITANCE[1]

BY ROBERT SIDNEY ELLIS

By what standard shall we determine whether or not a trait is inherited? The problem is difficult and complex because, on the one hand, children may show parental traits as a result of imitation and, on the other hand, in view of the mechanism of inheritance, it is clearly not necessary for a trait to appear in the parents in order to be inherited by the children. When there are qualitative differences, as in eye color, or when there are gross quantitative differences that are inherited as units, as in the case of tallness and dwarfness in Mendel's peas, it is very easy to trace inheritance. But there are probably few really qualitative mental differences between individuals, and we have no way of knowing as yet to what extent the quantitative variations in mental traits may be inherited as units. The inheritance of mental traits may be inherited as units. The inheritance of mental traits is, therefore, more difficult to determine than the inheritance of many physical traits. But the problem is by no means insoluble.

Before considering a trait hereditary we should determine whether the evidence indicates that it can be produced by any known environmental influence. If it is due to such influences, then, obviously, we have no grounds for considering it hereditary. We know that the ability to read depends on special instruction and activity. We would not, therefore, consider reading as an inherited ability. In certain instances we are able to explain the loss of mental ability by the effects of a disease such as meningitis. In that case we do not consider the resulting level of mental ability as inherited.

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[1] Adapted from *The Psychology of Individual Differences*, pp. 168–71. New York: D. Appleton & Co., 1928.

A very important criterion of the inheritance of a trait is the extent to which it may be modified by environment. Eye color cannot be changed by ordinary environmental agencies. It is hereditary. So if we find a mental trait which appears in the ordinary course of events but is not produced or greatly improved by training, we may assume it to be hereditary. If we find it also in the parents or in their relatives, that will, of course, strengthen our case.

The fact that a trait may be modified by experience does not in itself prevent the original aspect from being considered hereditary. It only makes the problem more difficult. There are three methods by which we may determine original individual differences in case of traits that may be greatly influenced by training and experience: We may study the trait before it has been influenced by training; we may compare different individuals after uniform amounts of training or we may give the best and most extensive training until the different individuals have reached the limit of improvement. The first method is very difficult and requires the detailed study of infants and young children. In studying some traits it is impossible. The second method is the one most commonly followed. The third method is more laborious, but when it can be applied it can be counted on to give a more certain idea of native individual differences.

In some instances, as in the study of instincts and emotions, a comparison with higher animals may be useful. When it is found that a dog, a monkey, and a man will all without special training react similarly to the same kind of stimuli, as to blows, there is good reason for considering the reaction tendency as being innate and hereditary. Similarly when psycho-motor capacities are found uniformly in the higher animals below man as well as in man, there is good reason for considering them innate and hereditary.

At times the principle of the normal distribution curve will prove useful in determining whether traits are inherited or not. In the case of "general" mental ability there is some evidence to show that the curve is skewed somewhat: there are more low-grade cases than there should be. We may fairly credit this excess to the action of disease and other detrimental factors.

A fundamental test of the inheritability of mental traits is found in the extent to which traits of parents and children correlate and the extent to which traits of different children of the same parents correlate with each other. By appropriate comparisons the effect of the environment can be eliminated or held constant and the correlation due to heredity can be determined. In the long run it is usually essential that a trait meet this test satisfactorily before being considered hereditary. After eliminating the effects of the environment, the trait must be found to depend on the organic inheritance from the parents before the case can be regarded as conclusively proven. Due, however, to the fact that genes and determiners are the things actually transmitted and that various mental traits are to be thought of as resulting from these, we must not expect that inherited traits will be, in all cases, strikingly like those of the parents. The mulatto inherits his skin color, but it is like that of neither of his parents.

The mental characteristics of twins supply important material for determining the relative influences of heredity and environment. Ordinarily twins have as nearly as is possible the same environment, so that differences can be ascribed to heredity. In the case of identical twins, on the other hand, it is possible to ascribe differences to the action of environment. In some cases identical twins have been separated and have grown up in different environments. Similarities in such cases are clearly due to inheritance.

CHAPTER XXII

WORK, REST, AND SLEEP

1. WORK AND REST[1]

BY EDWARD S. ROBINSON

Mental and physical work.—Practically every activity of the organism is in a sense work. The circulation of the blood, the digestion of food, the lifting of a weight, the multiplication of one number by another—all these use up energy in producing their result. As psychologists, however, we are immediately concerned only with those types of work which include mental processes as important elements.

Even with this limitation we have a wide field before us. Obviously, we may expect to study such activities as arithmetical calculations, the writing of essays or verse or anything that can be written, the translation of a foreign language, and so on. There are other types of work which on first thought may seem to furnish only physiological problems, but which nevertheless are so dependent upon mental processes that the psychologist finds much in them to interest him. The periodic lifting of a weight with one of the fingers, as is done in the ergograph experiment, is, when superficially examined, purely a matter of muscular capacity. But that this is not the case is evident when one inquires into the causes of fluctuations in the efficiency of such work which inevitably occur if it is long continued. One of the principal reasons why the subject loses his ability to lift the weight to the maximum height permitted by the nature of the apparatus is that the sensory processes of pain interfere with the full flexion of the finger in a way that the subject cannot disregard. Perhaps a better illustration of the rôle of mental processes in what would ordinarily pass as purely physical work came out in the performance of a rather frail young woman who a year or so ago was hypnotized before one of the classes in our laboratory. This subject was instructed by the operator to hold her right arm out at her side and to keep it there until she was told that she might lower it. The operator also told her that no matter how long she might hold her arm in that position it would not pain her. At the same time several of the more robust men in the room, who, of course, were not hypnotized, were also told to hold out their right arms and to see if they could keep them there until the young woman lowered hers. Not a great many minutes passed before the arms of these men were quivering and their faces were writhing with pain. The hypnotized subject held her arm steady, and smiled. Finally the last of the men lowered his arm and fell into a chair exhausted. Several minutes later the young woman lowered her arm, but only because she was instructed to do so by the operator. Evidently the greater ability of this woman to hold her arm out at her side was not a matter of mere muscular capacity. But the pain of which the men were so vividly conscious that they could no longer resist its demand was in her case so dissociated that the performance of her task was not interfered with.

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[1] Much of this section is based upon an article entitled "Mental Work" which appeared in the *Psychological Bulletin*, XVIII (1921), 456–82. A bibliography is attached to that article.

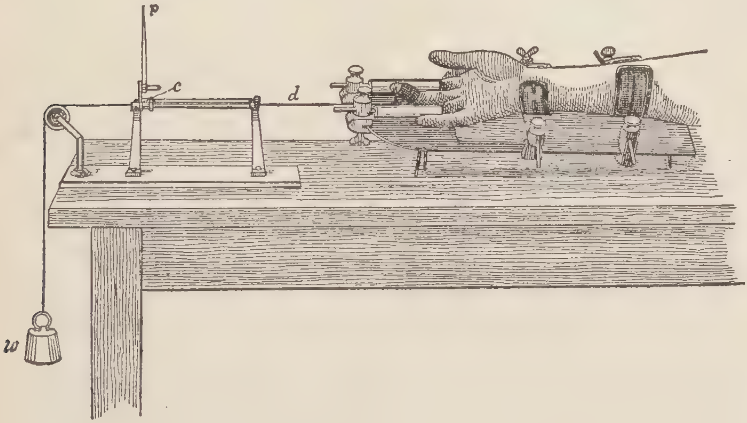

FIG. 102.—Mosso's ergograph: *c* is the carriage moving to and fro on runners by means of the cord *d*, which passes from the carriage to a holder attached to the last two phalanges of the middle finger (the adjoining fingers are held in place by clamps); *p*, the writing point of the carriage, *c*, which makes the record of its movements on the kymographion; *w*, the weight to be lifted. (From Howell.)

While it is true that such muscular work as lifting involves, and in a way depends upon, psychological processes, it is also true that there is no mere "thinking" independent of muscular activities. Probably there is no one who, when he thinks strenuously, does not make considerable use of his muscles, especially those of the throat and face. There are individuals who feel the results of prolonged thinking in the shape of pain in the eye muscles, and there are others who, after thinking for some time, feel unable to relax the muscles of face or throat.

One thing quite apparent from the above discussion is that the sharp line drawn between mental and physical work in every day speech is based on rough and ready distinctions rather than upon those of a scientific sort. Even in our scientific discussions we may at times speak of arithmetical calculations, the writing of poetry, and the like, as mental work, and of weight lifting, tapping as rapidly as possible, and the like, as physical work. And this distinction may serve a certain purpose, but we should always keep in mind its limitations.

The criteria of efficiency.—In studying work we are interested in its efficiency and the variations that occur in that efficiency from time to time. But what we mean by the term efficiency is itself a somewhat complicated matter. Sometimes we refer to the accuracy of work, sometimes to its speed, sometimes to the effort that produces it, and sometimes to all of these combined. There are types of work where accuracy alone may be considered. For instance, Professor McDougall in some of his experiments has used a device called the dotting machine. An endless tape with dots upon it moves before the subject, presenting a given number of dots for each given interval of time. The subject marks certain of these dots and performs another operation (that we need not describe) when others appear. The speed of work is in this case set, and accuracy is the only remaining objective criterion of the subject's performance. In some cases, too, speed can be taken as the criterion of efficiency and accuracy neglected. In some experiments performed in our laboratory we have had subjects recite the alphabet backwards as rapidly as possible. The practiced subject makes so few errors in this task that accuracy may be neglected, and speed taken as the criterion of efficiency.

Unfortunately, when we study usual types of work, speed and accuracy, or quality, are likely to vary at once. There is seldom any doubt as to what is meant by speed and accuracy. Speed is a matter of seconds or minutes for specified amounts of work, or units of work done in specified units of time; and accuracy is a matter of the amount of work done without errors. Still, either of these may be difficult to interpret unless the other one is kept constant. Working under one condition a subject may perform ten correct calculations and no incorrect calculations in ten minutes; under another condition he may perform ten correct calculations and five incorrect calculations in ten minutes. If accuracy be left out of account the subject may be said to have worked faster under the second condition, but if accuracy be taken into account, one might say that the speeds of performance in the two cases were equal. It is necessary, therefore, in estimating the speed of any work to decide whether we are going to estimate, say, amount done correctly or the total amount done. In a similar way it may be necessary to make a distinction between the accuracy or quality of work with speed taken into account and with speed left out of account.

The third criterion of efficiency is effort expended. Unfortunately we cannot measure the exact amount of energy involved in most of the performances in which we are interested. The working individual exhales larger amounts of carbon dioxide than the individual at rest, but very strenuous mental work causes such a small increase in the carbon dioxide production that it is practically impossible to measure it. But by the effort that a piece of work requires we do not necessarily mean simply the energy consumed. We may also mean by effort the increase in such discomfitures as pain, boredom, and the like which the continuance of work may cause. One method of determining effort simply requires a report from the subject concerning the amount of effort that he is expending. Such reports may be given in the subject's own words or they may be given in some more systematic form, as in terms of a scale, the extremes of which might be *very little effort* and *very great effort.* On the other hand, we might estimate this effort factor in some less direct manner. In some experiments the force of the subject's movements, his rate of breathing, or heart beat have been measured, and these have been considered to represent effort expended.

Learning as a change in efficiency.—Almost any kind of work improves in efficiency with practice and a great many of the activities in which we engage are improving indefinitely as we repeat them. The psychologist in his studies of work is not, however, primarily interested in those variations in efficiency caused by practice. Practice is itself such an important factor in mental life that it is usually considered (in the chapters on learning, or habit-formation, and memorizing) apart from those other factors which determine the efficiency of work.

The curve of work.—Every one is familiar with the fact that highly continuous work without rest causes very definite changes to take place in the accuracy, speed, or effort of that work. Such changes are studied in the laboratory by constructing so-called curves of work. Figure 103 shows such a curve constructed on the basis of the records of a subject who recited the alphabet backward continuously for a period of twenty minutes. Figure 82 is the curve of work for a subject who multiplied mentally four place by four place numbers continuously for a period of twelve hours.

The most universal characteristic of continuous work is that, if it is long enough, it shows a general falling off in the subject's efficiency. This may conveniently be designated the *general decrement.* The exact amount of this decrement depends upon many factors, among the more important of which is the criterion of efficiency considered. The accuracy or quality of work in many cases shows a more marked decrement than the speed of work. Subjective reports of the satisfyingness of work have been shown by Thorndike to develop a more marked decrement than quality or speed in the cases of poetry writing and composition grading. He had five subjects work continuously at the latter task for four hours. The average errors in successive sixths of the work were in the proportions:

100 99 98½ 98 92 92

The average speeds required for successive sixths of the work were in the proportions:

100 95 93 95 94 97

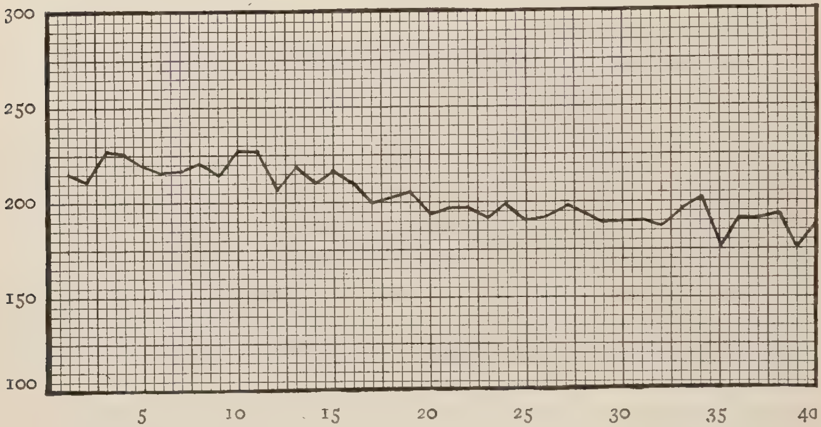

FIG. 103.—Twenty-minute work curve for reciting alphabet backward. Curve represents composite of four performances for one subject; horizontal scale represents successive 30-second intervals; vertical scale represents average number of letters recited in 30 seconds.

The average scores for satisfyingness were for successive twelfths of the four hours:

6.0, 5.7, 5.2, 5.0, 4.6, 4.3, 3.6, 3.3, 2.8, 2.4, 2.5, 2.2

These results show us that one's feelings of boredom or tiredness may give little information about the accuracy or speed of one's production. It is also quite possible that when working under some strong incentive, a task may remain full of satisfyingness long after one's accuracy and speed have begun to deteriorate seriously.

Usually the general decrement develops gradually, but it may not do so in all cases. Painter, after a busy day and evening spent at work of an intellectual kind, began at 11.00 P.M. to perform four place by four place multiplications mentally. After working at top speed until shortly after 3.00 A.M., he suddenly became unable to continue. He then tried to perform simpler arithmetical calculations, but he was as unable to do them as the harder problems. As a result of his experience, he suggests "that there exists a definite and relatively abruptly appearing point beyond which mental work becomes impossible."

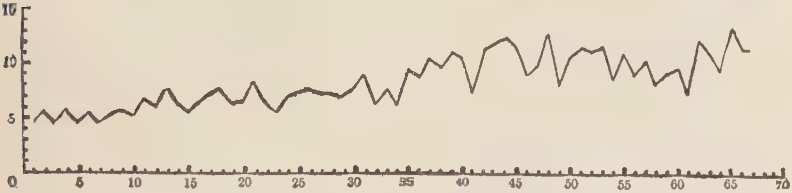

FIG. 104.—Curve showing the gradual increase in time required to multiply (subvocal) one four-place number by another. The work was done continuously from 11 A.M. to 11 P.M. The times of solving the first example on each of the four days are averaged, giving the first point on the curve; the times of solving the second examples on each of the four are similarly averaged, giving the second point on the curve. This procedure was repeated to the sixty-seventh example, which was the number completed on each day. The curve was constructed by the author from Dr. Arai's tables. It is not corrected for errors. The vertical line gives time in minutes; the horizontal line, the number of examples. (From Watson, courtesy J. B. Lippincott Co.)

The possible causes of the general decrement are several. In the first place, the reserve material of the muscle, nerve, or sensory cells involved may be consumed more rapidly than it can be restored by the processes of anabolism. In the second place, waste products may be produced in the nerve cells, at the synapses, or at the end plate where nerves and muscle join, at a more rapid rate than they can be eliminated. These factors are embraced by the *physiological* conception of fatigue. Probably they play a part in any general decrement in the work curve, but where a curve represents such highly complex processes as arithmetical calculation or writing verse, let us say, there are certainly many causes, besides these, producing the decrement, and these other causes may be more important than the *physiological* ones. The sensory processes involved in the discomfort incident upon continuous mental multiplication probably do more to decrease the efficiency of performance than do the consumption of reserve material and the production of poisonous waste products. The term *mental fatigue* may be employed to designate that highly complex set of *physiological* and *psychological factors* which produce the general decrement in such work as is commonly called mental or intellectual.

The general decrement is not the only characteristic of curves of work. There are other characteristics of this curve which, while not invariably present, still may be obtained under the proper conditions. Sometimes the efficiency of performance is very high at the outset of the curve, and then falls off quite abruptly to a level from which the general decrement develops more gradually. This early high point of efficiency is technically known as an *initial spurt.* Figure 83 demonstrates a number of work curves in which this initial spurt is prominent. Such a spurt may appear because the subject at first overestimates his capacity. The suggestion has also been made that initial spurt is more likely to occur in arithmetical work than in most other cases, the reason for this being that in the first moments of such work the subject is relatively free from interfering factors. After a number of calculations have been made involving most of the digits, subsequent calculations are likely to be interfered with by those already performed. The only objection to this theory is that initial spurt is not always present even for arithmetical work. Another factor pointed out by Chapman and Nolan which may at times tend to determine whether or not initial spurt will be present in a given curve of work refers to our methods of keeping track of the subject's performance. If the curve is plotted through points which represent the averaging of achievement for comparatively long intervals of time, the initial spurt may be negligible or even unobservable. If in the same experiment the successive intervals of time for which records are taken are small, then an initial high point of efficiency (in case the duration of that high efficiency is short) will not be as likely to be eliminated by the process of averaging.

Another occasional characteristic of curves of work is known as *warming-up*. Where warming-up is present, the curve of work rises for a short period at the outset of the work and then continues at a level or falls away in the general decrement. Of course, any work at which the subject is improving with practice is likely to show an initial increase in efficiency before it shows a decrease, but warming-up in such cases may be considered spurious. It is due to the fact that our work curve is also a learning curve. We can claim to have a genuine instance of warming-up only when the initial rise in efficiency cannot be accounted for by the fact that the work is still improving with practice. This practice effect may be eliminated in either of two ways. The soundest method of eliminating it is by examining only such curves of work for the activity in question as are obtained after

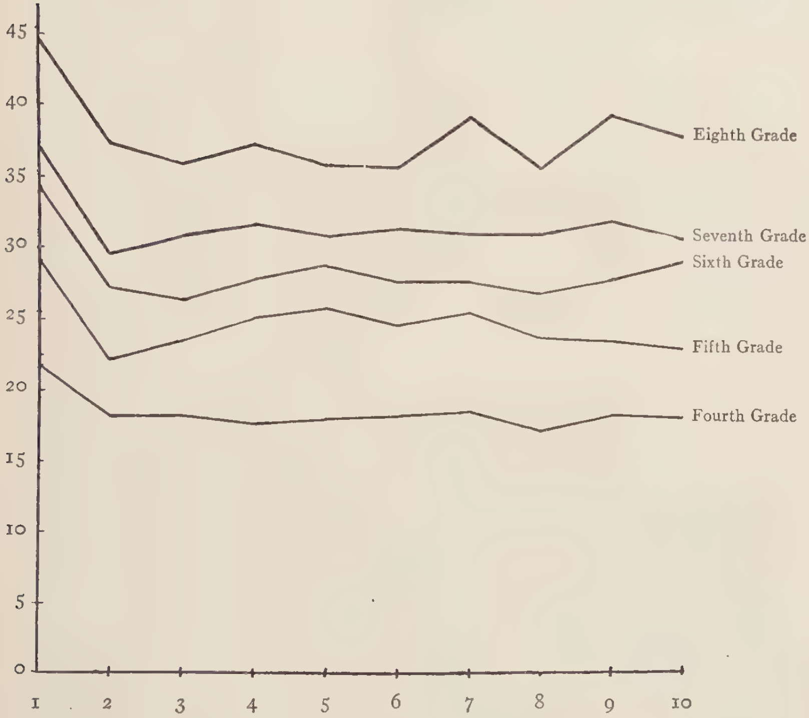

FIG. 105.—Work curves in subtraction; vertical scale, number of correct operations; horizontal scale, the successive minutes of the test. (From Phillips.)

the subject has reached the limit of his capacity for learning in this activity. In case it is impracticable to get our subject to the limit of his learning capacity before deciding upon the presence or amount of the warming-up effect, we may determine the rate at which his learning is taking place by examining his efficiency during initial stages of the work for a number of successive days, and then subtract the rate of improvement there shown from the initial rate of improvement during a single continuous performance. If the initial improvement during a single performance is greater than that from one day to the next, then and to that extent we may claim to have an instance of warming-up. In the case of complex intellectual work, this warming-up is probably due to the fact that the subject must each day adjust himself to the specific conditions of the experiment before he can manifest his maximum efficiency. In work where large groups of muscles are employed, as in performances of athletes, the same process of adjustment may be required, and also the earliest stages of the work may initiate glandular or circulatory activities that favor the work's efficiency.

Where curves of work do not reveal the warming-up effect, it does not mean that the causes which sometimes produce this effect are absent, but simply that they are less potent than causes producing either initial spurt, or the general decrement, or both. This fact is illustrated by a recent experiment performed in the Chicago laboratory. The subjects tapped as rapidly as possible for two successive five-minute periods. These periods of tapping were separated by rest intervals varying in length. As can be seen in Table XXII, the subjects made more taps during the second five minutes of work than during the first five minutes, except where the interval between the two periods of work was zero. Furthermore, the excess of taps in the second five minutes over that in the first five minutes was greater than that which could be accounted for in terms of the improvement going on in these subjects from day to day. In other words, warming-up was present where the work possessed a certain amount of discontinuity, and it was absent where the work possessed a certain amount of continuity. Where it was absent we may assume that the general decrement obscured it.

When the subject of an experiment knows that the work is to end at a certain time, he is likely to demonstrate an increase in efficiency as the termination of his performance approaches. This final rise in efficiency is known as the *end spurt*. Its appearance, of course, is due to the fact that under the incentives operative during the course of the work the subject does not perform at the very limits of his capacity.

Most curves of work are full of irregularities which represent fluctuations in efficiency due to miscellaneous causes. In the complex operations that are usually considered in experiments on work, it is possible for discomfort, for instance, to arise which produces temporary losses in efficiency, and this discomfort may readily be compensated for by slight variations in posture or in methods of work. Temporary periods of low efficiency may also allow a certain amount of rest which is naturally followed by a rise in efficiency.

TABLE XXII*

Showing in Percentage Terms the Excess of Warming-up over Practice from Period to Period Where the Work Varies in Continuity. Average Results for Twelve Subjects

Intervals between Two Five-Minute Periods of Tapping	0 Seconds	80 Seconds	1,200 Seconds
First cycle†	−4.3	+0.7	+2.1
Second cycle	−0.9	+1.8	+2.9
Third cycle	−2.7	+2.4	+2.7
Fourth cycle	−1.8	+2.2	+2.9

* The detailed results upon which this table is based have not yet been published.

† A *cycle* is a fraction of the total experiment during which each subject was tested once under each condition of the experiment.

Effect of one kind of work upon another.—So far we have been considering the effects which the continuation of a given type of work has upon that same work. It is also clear that prolonged work of one sort will affect one's ability to perform other kinds of work. It is quite unlikely that a person who has worked for four or five hours at mental multiplication will be able to write poetry as rapidly or as well as he would be able to if he had spent the four or five hours in some less strenuous way. It is only in such extreme cases as this, however, that we can predict with confidence that the continuous performance of one type of work will deleteriously affect other types of work. We may be sure that efficiency along one line will be more susceptible to the deleterious effects of fatigue induced by work along certain lines than it will to the deleterious effects of fatigue induced by work along certain other lines, but just what factors determine the intimacy of this fatigue relationship between different types of work, we are still far from understanding. If one type of work produces physiological fatigue of the optic nerves or arouses the sensory processes involved in the pain of eye strain, then the probability of the individual's doing efficient work of any kind that involves the use of the optical apparatus is small. If the performance of one type of work keeps an individual in the house when he would like to be out of doors, he is likely to become less and less capable of doing efficiently any work which continues to prevent him from fulfilling his desires. Such factors as these may easily lie at the basis of the fatigue relationship between different kinds of work, but there are so many others of probably equal importance that anything like a complete catalogue of these factors would be impossible.

Effects of loss of sleep.—The effects of fatigue are, except in extreme cases, removable by rest. The most effective rest is that which the orgaism gets during sleep. Any prolonged loss of sleep will, therefore, interfere seriously with the normal functioning of the organism. Dogs that have died as a result of being kept awake for several days have shown marked cortical deterioration. Human subjects who abstain from sleep for two or three days manifest varying degrees of abnormality. Slips of speech, loss of muscular control, hallucinations, and the feeling of weakness are common. Some persons are sleepy during the whole of a long insomnia while others may feel that way only at intervals. A subject in one experiment who went sixty-five hours without sleep experienced very little sleepiness, but he did develop a state similar to intoxication, which gradually grew worse until he was allowed to go to sleep. Even a single sleepless night makes itself felt with most subjects as is seen in Table XXIII.

Despite all these disturbances brought about by loss of sleep, sometimes a relatively difficult type of performance fails to deteriorate. Three subjects who went without sleep for sixty-five hours were at the end of that time able to do mental multiplications and other difficult tasks with practically undiminished efficiency. These tasks were in the nature of tests, however, and that fact may easily have caused these subjects to exert more and more effort upon them as they felt their general capacities wane.

When an individual has gone without sleep for an unusual period it is not always necessary for him to make up all of the missed sleep in order to regain his efficiency. Patrick and Gilbert found that even an electric shock which would ordinarily cause a cry of pain would not awaken a subject who had been without sleep for many hours. This suggests that we may make up for insomnia by the depth rather than by the length of the subsequent sleep.

Rest pauses.—The introduction of rest pauses during a long period of work may increase production to an astonishing extent. Mr. E. D. Jones in his book, *The Administration of Industrial Enterprises*, describes two cases of this sort: "Mr. C. E. Knoeppel started with workmen who, at their own gait, had been producing 16 pieces per hour. By establishing a 25-minute working period and a 5-minute rest period, he obtained 18 pieces. By changing to 17 minutes of work and 3 minutes of rest, the output rose to 22 pieces per hour. Finally, by arranging a 10-minute work period and a 2-minute rest period, production became 25 pieces. In another case, a record of driving 1,600 rivets per day was obtained, the previous performance having been 600 per day, Mr. H. F. Stimpson establishing rest periods of 2 minutes between each 10 rivets, thus devoting 320 minutes, or 5 hours and 20 minutes out of the 10 hour day to rest, and employing a schedule of 1¾ minutes of work and 2 minutes of rest."

TABLE XXIII*

REPORTS OF FEELINGS OF TIREDNESS, GIVEN IN PERCENTAGES OF SUBJECTS RATING EACH DEGREE OF TIREDNESS. IN THE COLUMNS MARKED *SLEEP* ARE THE RATINGS OF 39 SUBJECTS WHO LED NORMAL LIVES DURING THE EXPERIMENT. IN THE COLUMNS MARKED *INSOMNIA* ARE THE RATINGS OF 25 SUBJECTS WHO WENT WITHOUT SLEEP ON THE NIGHT OF DAY 1

DEGREE OF TIREDNESS	DAY 1		DAY 2		DAY 3	
	Insomnia	Sleep	Insomnia	Sleep	Insomnia	Sleep
Very tired	4	7.9	41.6	2.6	8	13.2
Tired	36	26.3	41.6	47.3	60	36.8
As usual	52	60.5	17.6	44.7	28	50.0
Fresh	8	5.3	0.0	5.2	4	0.0
Very fresh	0	0.0	0.0	0.0	0	0.0
Totals	100	100.0	100.8	99.8	100	100.0

* Adapted from *Journal of Experimental Psychology*, V (1922), 97.

It is probably impossible to discover any a priori method for determining the optimal number and length of rest periods for any particular type of work. Results, like those quoted above, simply indicate what can be done when an investigation is made for a specific task. The determination of these optimal rests should, of course, take into account their effects upon the attitude of the worker and upon his long-run productivity as well as upon his temporary output.

Distraction.—When any unusual stimulus, such as a loud sound, is present, one is likely to react to it as well as to those stimuli related to the work one is doing. This secondary reaction is likely to interfere, at least temporarily, with one's efficiency. If the distracting stimulus is continuously present, one may come to disregard it, or one may compensate for its presence by exerting more effort upon the task at hand. Morgan introduced distracting sounds where subjects were working at a test requiring a complex series of movements. The efficiency of these subjects, or at least their rate of work, increased in the presence of the distractions, but it was discovered that this took place only because of an increase in effort expended when the distraction was present.

The absence of a customary stimulus may also act as a distraction, even though it be only remotely related to the individual's work. Johnson had subjects sort cards by touch in a good light and in darkness. Although vision was not an aid in this work, the subjects performed better in the light. One interpretation of this result is that the absence of light was a distraction. The same point is illustrated by the individual who finds his thoughts interrupted by the stopping of a clock, the ticking of which he had not previously noted.

Incentives.—There are certain factors present in any work which we call incentives. They may be ideas of the remote or immediate consequences of the work, or merely a vague awareness of how the work is going or of the conditions under which the work is being done. Professional ideals may operate through many periods of work, while an immediate desire for food or for some other temporary satisfaction may determine our efficiency during a shorter period. Experiments have shown that children work better when there is a reward in sight or when they know that their records are to be published. In certain cases the efficiency of workers has been increased simply because other workers were near, even though no definite element of rivalry entered the situation.

Not all incentives are positive. One may increase his efficiency to avoid shame or punishment.

The experimental investigation of incentives is particularly difficult because there are as many possible incentives for work as there are desires and fears in human life. And the more vital these are in everyday life, the more difficult it is to work with them under controlled conditions in the laboratory.

Diurnal variations in efficiency.—An individual's efficiency varies during the course of the day. School children improve in their capacity to perform certain intellectual tasks during the morning. Early in the afternoon there is a low point in their diurnal curve of efficiency followed by a rise. There is probably another falling-off late in the afternoon. A similar variation has also been found by Gates for college students. Feelings of fatigue according to Muscio show a general increase during the day. The only interruption in this general increase in "tiredness" occurs just after luncheon.

The interpretation of the diurnal curves of efficiency is somewhat difficult. Undoubtedly such curves depend upon the kind of efficiency considered, upon the usual work habits of the subject, and so on, as well as upon a possible fairly constant organic rhythm. That such a rhythm may exist is not at all unlikely. A number of experimenters have found that the depth of sleep varies in a surprisingly regular manner (see pp. 798 ff.), and it is quite possible that a similar rhythm operates during our working hours.

Fasting.—The effects upon mental capacity of going without food are by no means clearly made out. This may be due to a number of causes. The effects may be very complex, the tests so far employed may be lacking in delicacy, and important after-effects have undoubtedly escaped notice due to the fact that adequate "after" tests on this condition have yet to be made.

Langfeld made daily examinations of Agostino Levanzi, a lawyer of Malta, who underwent a 31-day fast at the Boston Nutrition Laboratory of the Carnegie Institution of Washington. Due to unavoidable circumstances there were only three days of testing before the beginning of the fast and no adequate tests at the completion of the fast. A considerable number of tests were used and from their results Langfeld concludes that, "there was a loss in muscular strength due probably to loss of tissue, a possible gain in sensory acuity and a decided increase in the efficiency of all the central processes." (The efficiency of the central processes, of course, is supposedly measured by the more complex intellectual tests.) The loss in muscular strength is obviously a fact caused by fasting. The improvement in sensory acuity and "central processes" is not so clearly so. Possibly in certain of the sensory acuity tests and surely in the "central processes" tests there is a rise due to practice which is to be expected, fast or no fast. The only conclusion to be drawn, then, in respect to these tests is that practice effects in them were not obliterated by the period of fasting. Such effects may have been either positively or negatively accelerated, or they may have been unmodified. The subject's belief in the advantages of fasting was such that introspective reports could not be relied upon. There were some indications of irritability which may have been caused either by the fast or by the monotony of the subject's life under the conditions of the experiment.

Effects of drugs.—Watson points out three limitations present in many of the experiments on the effects of drugs: (1) "Only in rare cases has a function been practiced sufficiently in laboratory studies before control tests were introduced to gauge the effects of drugs, continuous exercise, loss of sleep and other factors." (2) "Too narrow functions have been studied—rarely has any of the work been done upon functions used in daily life. . . . . " (3) "The functions have been followed through for entirely too short periods for wide generalizations to be made." In general, research workers have become increasingly careful to avoid these sources of error, but it is frequently impossible to avoid all of them. Take, for example, the subject's attitude. In some cases it is practicable so to disguise a given drug that the subject will not know whether he has taken caffeine, say, or sugar of milk. Experiments with alcohol and tobacco, however, present more difficult problems. The flavor of alcohol is not easily disguised and, if doses of any size are employed, its almost immediate subjective consequences are quite apparent. And a really adequate experiment on tobacco smoking should provide for a control in the form of smoke from which all effective elements have been removed. It is likely, however, that where completely disguised doses of a given drug are impossible, longer series of measurements with more subjects eliminate to a considerable extent differences due merely to attitude.

Alcohol.—Experiments reported in 1911 or earlier[1] indicate that alcohol usually acts detrimentally on mental functions. This is quite certain where complex processes are involved and where the doses are moderate or large. While the results from very small doses or in very simple processes are doubtful there is at least no clear evidence here for either permanently or temporarily increased efficiency. It seems quite probable that where small doses failed to cause bad effects it was due either to the extreme variability of the function studied or to the fact that the subject put forth an increased effort to offset a lowering capacity of which he was aware. From these earlier experiments it also appears that the effects of alcohol are more evident in the quality than in the quantity of work.

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[1] K. J. Karlson, "The Mental Processes as Affected by Alcohol," *Pedagogical Seminar*, 1913, 20, 322–342. (A review of literature on alcohol.)

Later work has on the whole substantiated the conclusion that alcohol has a detrimental effect upon mental operations. Frankfürter, working with himself as subject, found that 20 c.c. doses of alcohol decreased the accuracy of his typewriting and also, be it noted, his speed.

Dodge and Benedict conclude from the results of an extremely careful series of experiments that alcohol is a depressant rather than a stimulant. This is shown in the following tabulation of their results quoted by Hollingworth and Poffenberger:[1]

	Per Cent
Increase of latent time of knee-jerk	10
Decrease in the thickening of the quadriceps muscle	46
Protective eyelid reflex, latent time increased	7
Extent of eyelid movement decreased	19
Eye reactions, latent time increased	5
Speed of eye movements decreased	11
Sensitivity to electric stimulation decreased	14
Speed of finger movements (tapping) decreased	9

Miles has in two papers published findings which in general verify those of Dodge and Benedict. We are safe in concluding from the thorough and rigorous experiments of Dodge and Benedict, and Miles, that even in the realm of comparatively simple processes alcohol is mainly a depressant and that the detrimental effects of alcohol (this conclusion finding support from Frankfürter) are clear in respect to speed as well as in respect to quality of work.

McDougall and Smith obtained results demonstrating that alcohol usually has a deleterious effect upon mental efficiency. Varying doses of alcohol increased the number of errors in the dotting machine experiment as follows:

Dose	Increase in Errors Per Cent
10 cc	21
15 cc	42
20 cc	39
25 cc	113

A memory test also showed that alcohol lowers efficiency.

The same investigators studied the effects of two different concentrations of alcohol. Twenty c.c. of absolute alcohol diluted to 60 c.c.

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[1] Hollingworth, H. L., and Poffenberger, A. T., Jr., *Applied Psychology.* N.Y.: Appleton, 1917. P. 172.

water increased the errors in the dotting machine test 160 per cent. Twenty c.c. of absolute alcohol diluted to 200 c.c. of water, on the other hand, increased the errors by only 22 per cent. They also report that the effect of alcohol is much less evident if the alcohol is taken with a meal. When 30 c.c. was taken under such circumstances it had little or no influence upon efficiency.

The efficiency-reducing capacity of alcohol is further verified by Jörger who found that this drug increases free association time and lowers the quality of the response, and by Arlitt who found that alcohol affects the learning ability of white rats to which it is fed and also that of their offspring.

The old notion, still popular in some non-scientific quarters, that alcohol may have at least temporary beneficial effects probably grew out of a misinterpretation of a very real fact about alcohol, namely, that the subject who has taken a moderate amount of it is inclined for a time to over-rate the excellence of his own performance. McDougall and Smith report this tendency, and popularly we are aware that many a story of keen wit becomes dull when its audience is free from the effects of alcohol.

The possibility remains that there are important individual differences in the degree of susceptibility to effects of alcohol. In fact the reality of such differences hardly needs confirmation. But whether some individuals are actually stimulated by a drug which depresses others is still another matter. Dunlap tested certain eye-hand co-ordinations of two subjects each of whom was given within about one hour 7 ounces of rye whiskey. One of these subjects became obviously drunk and his co-ordinations clearly disturbed. The co-ordinations of the other subject seemed to improve a little during the experiment, and he felt no ill effects until a vomiting spell 8 hours after taking the whiskey. The data are too meagre, however, to justify the conclusion that the second subject was made even temporarily more efficient by the whiskey.

Caffeine.—Most of the evidence which we have upon this subject indicates that moderate amounts of caffeine (amounts such as are found in the ordinary cup of tea or coffee) increase the efficiency of mental activity, and there is little reason to believe that this rise in efficiency is followed by a noticeable decrement. The effects of larger doses are sometimes unfavorable, depending upon the operations considered and the subjects.

Table XXIV gives the main results of Hollingworth's investigations of this subject:

TABLE XXIV

St. = stimulation 0 = no effect Ret. = retardation

Test	Small Doses	Medium Doses	Large Doses	Secondary Reaction
1. Tapping	St.	St.	St.	None
2. Three-hole	St.	0	Ret.	None
3. Typewriting:				
a) Speed	St.	0	Ret.	None
b) Errors	113 Fewer for all doses			None
4. Color naming	St.	St.	St.	None
5. Opposites	St.	St.	St.	None
6. Calculation	St.	St.	St.	None
7. Discrimination reaction time	Ret.	0	St.	None
8. Cancellation	Ret.	?	St.	None
9. S.W. illusion	0	0	0	....
10. Steadiness	?	Unsteadiness	....	None

The sleep of the subjects was generally untroubled except where large doses were taken. In that event such symptoms as headache, dizziness, feverishness, and irritability were also liable to be present. The degree to which sleep and feelings of well-being were affected by caffeine varied with the body-weight of the subjects. The heavier ones were less affected.

Hollingworth points out that quantitative results from investigations of the effects of caffeine in its pure form cannot be compared uncritically with its effects when administered in tea, coffee, and other beverages. Hollingworth's experiments show that caffeine has a greater effect when taken on an empty stomach. This statement may well be kept in mind in regard to other drugs. The effects of alcohol, as we have noted, vary considerably according to the form of administration.

Tobacco.—It has been established for some time that excessive smoking is injurious to the physical organism. Just what amount of smoking should be regarded as excessive and just how injurious a given excess is depends within rather wide limits upon the individual smoker. Certain correlations have also been pointed out between tobacco smoking and such measures of intelligence as school marks. With practically no exceptions groups of non-smoking students make better marks than groups of smokers. But the earlier disposition to interpret this fact as a sign that tobacco smoking has a detrimental effect upon intelligence has been checked by more careful analysis. It is quite possible that where small boys take up smoking they do so because they lack certain social inhibitions, and the lack of these same, or closely related inhibitions, may also be a cause of their disregarding scholastic duties. Among older boys perhaps the socially more intelligent are in a position where the tobacco habit is more easily cultivated. And they may also be in a position where there are a maximum number of distractions from purely scholastic activities. Thus, one aspect of intelligence might be the cause of both tobacco smoking and low scholarship. In other words the true state of affairs is far more complex than that suggested by the statement of a single causal relationship between tobacco smoking and intelligence or even tobacco smoking and scholarship.

Experimental studies of the effects of tobacco smoking upon mental functions indicate in general that, whatever the amount of this effect, it is detrimental. While Berry found that he added slightly more accurately or more rapidly after smoking a cigar, Bush, Johnson, and Froeberg obtained some evidence of an advantage in the other direction. As far as these experimental studies go they indicate that the effects of tobacco smoking on mental efficiency are very slight. Before taking such a conclusion seriously, however, one should examine some of the limitations of its factual support:

1. During these experiments the smokers used much less tobacco per day than does the ordinary user of the drug.

2. The effects considered are those accruing from small and isolated amounts of tobacco smoking rather than from the relatively continuous indulgence characteristic of smoking in everyday life.

3. No one has yet devised an adequate control dose (i.e., a dose minus any effective agents) of tobacco smoke. Consequently differences of attitude are bound to arise between the "smoke" and "nonsmoke" groups for which it is impossible to make accurate allowance. Such attitude differences are especially important where the data do not point very strongly to the advantage of one condition, as is the case of these experiments in tobacco smoking.

So far it has not been proved that tobacco smoking aids mental efficiency. But for moderate smoking neither has the opposite been clearly established. Writers who wish to defend tobacco smoking or to seem nonpartisan to tobacco smokers sometimes argue that, whereas tobacco smoking may have some detrimental effects, so has the elimination of tobacco smoking a detrimental influence upon the smoker who is not accustomed to doing without it. This, of course, holds good for any drug, and it is probably less true for tobacco than it is for the more harmful drugs, such as alcohol, opium, etc.

Atmospheric conditions.—The psychological effects of oxygen deprivation were very carefully studied during the war in connection with the aviation service. Lack of oxygen was secured by a rebreathing apparatus by means of which the subject rebreathes the air from a supply tank, thus reducing the oxygen content, or by means of a diluting apparatus. These devices were standardized with reference to a low-pressure tank in which air could be rarified to correspond to any given altitude. In the British investigation the effects of oxygen deprivation were frequently determined by tests after flight. Ability to stand oxygen deprivation varies considerably. Of each 100 carefully selected American flyers only 61 are physically and mentally capable of attaining an altitude of over 20,000 feet with safety; 25 out of each 100 are physically and mentally unsafe at altitudes above 15,000 feet; and 14 out of each 100 are physically and mentally unsafe at altitudes above 8,000 feet. Of psychological processes the more highly organized are impaired first. Oxygen hunger has accumulative as well as immediate effects. One hundred hours of flying at high altitudes may render a man at first capable of effective work at 20,000 feet, incapable of effective work at 10,000 feet. On the other hand a subject may become adapted to a limited degree of oxygen deprivation.

The qualitative changes in behavior have also been reported in some detail. Depletion of the oxygen supply is accompanied by muscular twitching and tremor, inco-ordination, and overdischarge. The subject becomes less and less capable of normal attention, until finally he will heed instructions only when they are given insistently and in a loud voice. In the final stages emotional disturbances are not uncommon. Some subjects express uncontrolled anger, some become sullen, and others become silly.

A number of experiments have tested the capacity of subjects for mental work under various conditions of temperature and humidity. Possibly because of the comparatively short length of time over which these conditions were studied or the really insignificant differences between them, we are unable to state that these factors are of great importance in determining mental efficiency. We can of course say from non-experimental experience that extreme conditions of humidity and temperature are disturbing.

EXERCISES

1. Make an analysis of the specific elements involved in such activities as tennis-playing, studying psychology, watching a play.
2. Draw up an outline of all possible criteria of the efficiency of adding playing football, carrying on a conversation.
3. What are some possible causes of fluctuations in the work curve not mentioned in the text?
4. What is your interpretation of the fact that sleepiness may occur only intermittently during a period of insomnia?
5. Plan an experiment to test the effect upon general efficiency of some factor not mentioned in the text.

2. SLEEP

A[1]

BY ISADOR H. CORIAT

Sleep has been called a mystery, and it is a mystery well-nigh inscrutable. The very multiplicity of the theories on sleep shows how inadequate they are to explain the phenomenon, which from the earliest dawn of history has puzzled savage and scientist alike. To primitive man or to the uneducated savage, there was something uncanny in this "darkness and light that divided the course of time." The outward resemblance of sleep to death only served to increase the mystery.

The modern scientist has approached but little nearer to the final solution of the problem. Many theories have been proposed to explain sleep, from the earlier ideas that sleep is due to a lack of blood in the brain to the more recent biological and physiological conceptions. Each theory has its enthusiastic advocates and each can cite apparently unanswerable facts as a positive proof. In sleep, we seem to be dealing with definite alterations of the personality, but just how the waking personality falls into the state we call sleep and *how* this latter again changes to the waking personality, is the great enigma. Yet this cycle occurs in one form or another throughout almost the entire organized world. Sleep is necessary for all living beings, or rather for those beings which possess a central nervous system, no matter how rudimentary. Moving unicellular organisms, however, even when observed for hours at a stretch, show neither repose nor sleep. Their movements seem to be perpetual.

As a preliminary, it will be of interest briefly to pass in review the various theories that have been propounded to explain sleep. These

[1] Taken from *Abnormal Psychology*, pp. 88–96. London: William Rider & Son, 1910.

theories fall naturally into five groups, namely, physiological, histological, chemical, psychological, and biological. The pathological theories of sleep belong to a separate category and comprise only the abnormal sleep states as manifestations of certain diseases of the nervous system, such as hysteria, epilepsy, and the African sleeping-sickness.

PHYSIOLOGICAL THEORIES OF SLEEP

Sleep is due to changes in the cerebral circulation. A lack of blood in the brain causes what is known as cerebral anemia. This cerebral anemia may be due to a dilatation of the blood-vessels of the skin, which causes a fall of blood pressure in the brain. Sleep naturally results, in the same way that a lack of blood in the brain causes that transitory loss of consciousness known as fainting.

According to these circulatory theories of sleep, cerebral congestion, or an increased amount of blood in the brain, produces insomnia. Observations on exposed brains after the skull has been trephined for injuries, seem to bear out these circulatory theories on sleep. Mosso's famous observations in cases of this type showed a cerebral anemia during sleep. Yet strong pressure on the carotid arteries in the neck, for a short time, thus interfering with the passage of blood to the brain, causes a state of consciousness analogous to fainting, rather than genuine sleep.

HISTOLOGICAL THEORIES OF SLEEP

These are the theories which explain sleep as being produced by certain movements which the nerve cell prolongations are supposed to possess. These prolongations are technically known as the dendrites. All nerve cells possess dendrites which touch each other and by means of which nerve currents are supposed to be transmitted from one cell to another. According to this theory these nerve currents are necessary for consciousness and when there is any break in these currents, that is, when the dendrites spontaneously grow shorter, so that they no longer come into contact with one another, sleep results. The theory is a fascinating one and it has also been utilized to explain the mechanism of certain dissociations of consciousness, such as dreams, hysteria, and hypnosis.

CHEMICAL THEORIES OF SLEEP

Even modern physiological chemistry has tried its hand in the interpretation of such a purely psychological mechanism as sleep. It supposes that poisons are elaborated during the day, as the result of muscular and nerve activity, that these poisons are narcotic (sleep producing) in action and when they reach a certain amount, drowsiness, and then sleep, results. These poisons have a direct action upon the central nervous system, particularly the brain. In sleep, the poisons are no longer formed because in this condition there is a minimum of nerve and muscle activity. These toxic substances are eliminated during the night and when elimination is nearly complete, awakening results. This cycle of self-poisoning of the nervous system is repeated day after day. It is really a kind of auto-intoxication. A modification of this theory states that sleep is produced by a lack of oxygen in the brain. An excess of carbonic gas is, therefore, formed and the somnolent effect of this gas is a fact well attested by experience, such as occurs in improperly ventilated and crowded rooms.

PSYCHOLOGICAL THEORIES OF SLEEP

Sleep is an inhibition, a resting state of consciousness. Mental activity or consciousness is dependent upon peripheral incoming stimuli, and when these are absent, a lowering of mental activity follows and sleep results. According to this theory, if all peripheral stimuli are cut out, sleep will naturally follow. When we attempt to sleep, we voluntarily cut off all distracting external stimuli; we darken the room, lie quietly, stop all muscular activity, close the eyes, etc.

BIOLOGICAL THEORIES OF SLEEP

The interpretation of sleep as one of the essential life-phenomena is the basis of the biological conceptions as elaborated by Claparède and Sidis. In fact, Claparède interprets many abnormal psychic conditions from a purely biological standpoint. His biological theory of sleep has attracted considerable attention. According to him, sleep is not due to fatigue because fatigue frequently produces insomnia. Sleep is a negative state, a cessation of all activity. It is a reaction of defence to protect the organism against fatigue, rather than a psychological process, the result of fatigue. It is an instinct; we sleep not because our nervous system is poisoned or exhausted, but because we cannot help sleeping. He asks the very pertinent question—At what step in evolution did sleep first appear? In reply to himself he says, "Sleep did not necessarily exist at all times; it is, in fact, a contingent phenomenon, and is not implied in the conception of life; the lower forms of animal life, microbes and infusoria, do not manifest any sleep. If sleep has developed, it is probably due to the fact that those animals whose activity was broken by periods of repose or of immobility have been favored in the struggle for existence, for they have been enabled, thanks to the accumulation of energy, during these periods of immobility, to manifest in consequence a more intense activity. As to these periods of immobility, they are themselves derived from the function of inhibition of defence, which plays such a great rôle in the animal kingdom (simulation of death)."

The latest systemized research on sleep is by Boris Sidis, who interprets sleep from the standpoint of the threshold of cell energy. These investigations showed that sleep is due in the main to the cutting out of all peripheral stimuli. Relaxation and not fixation of attention is necessary for sleep, for this latter frequently produces insomnia. Suggestibility is absent in the sleep state. Three essentials are necessary for the production of sleep, namely, monotony of sensory impressions, limitation of voluntary movements, and inhibition. Of these three, the monotony of sensory impressions is the most important factor. In going to sleep, there is always an intermediary subwaking or hypnoidal state. This subwaking state is present, not only in man, but in the lower animals, such as dogs and kittens. Like Claparède, Sidis also considers sleep from the evolutionary standpoint. Sleep, therefore, biologically considered, is a reaction of protoplasm. It is as much an instinct as sex or hunger. Sleep is normal, psychological, not an evidence of the pathological, the diseased. Sleeping and waking are merely different manifestations of normal life-processes. When the organism becomes fatigued as the result of continued stimulation, those stimuli which have exhausted themselves or ceased to act on the organism by reason of their monotony drop out and are replaced by new ones, until the whole round of stimuli has been gone through. Then the organism ceases to respond to the stimuli and falls asleep. Organisms, therefore, fall asleep when the threshold for stimulation rises, and waken when the threshold falls.

We have thus briefly reviewed the principal theories of sleep. None of these, however, can explain all the facts relative to sleep. They merely give us hints here and there as to the ultimate, underlying mechanism. Self-poisoning of the nervous system, exhaustion, changes in the cerebral circulation or the movements of the nerve cell prolongations, while plausible, are only apparently scientific. They have been weighed in the balance and found wanting; they do not explain the real mechanism of the sleep state. We know that there is no parallelism between sleep and fatigue, because sleep is periodic and may be postponed by excitement, interest, and even volition. Sleep is not a disease, it is a natural instinct of the organism. With these facts in mind, the only satisfactory theories of sleep are those that are based on purely biological conceptions. Even if these theories should not prove to be the final solution of the problem, they are at present the best working hypotheses.

B[1]

BY H. L. HOLLINGWORTH

In the first place, note that sleep does not affect the entire organism. That important organ, the heart, for example, keeps up its work without ceasing, and with little or no change in rate. The diaphragm goes on working and the sleeper breathes. The simple reflexes, many of them at least, are in constant readiness for action. Even many of the voluntary muscles, such as those maintaining the posture of the body, may remain in contraction, so that one may sleep in a sitting position, or even, if the reports be true, standing, or riding on horseback. Certainly no theories based upon the action of poisons in the system, congestion, or anaemia of the nervous tissues, mechanical shrinking of the neurones, or adaptation to constant stimuli, are reconcilable with these facts. And if these important parts of the system never sleep, it is far from obvious why the rest of the system must pass into a stupor. The function usually attributed to sleep is the restoration of energy and the building up of tissues. But the most constantly employed organs and nerve centers seem not to need such a period of inactivity. Perhaps, it may be said, these organs recuperate in the intermittent inactive periods of their rhythmical work. But this intermittence of function is as true of our other organs, our hands and feet, eyes, jaws, and so forth, as it is of the heart and diaphragm. Why, then, do we require sleep at all? Here all the mechanical theories fall down again, for it is not clear why such mechanical accidents should not affect the sleepless organs also.

Note in the next place that sleep does not come on suddenly and irresistibly, as if produced by a mechanical process. We can delay sleep at will. You can, if you like, go to sleep during the reading of this chapter; or you can, with a certain effort, remain awake at pleasure, until nine o'clock or until midnight or even up to a period of four days. But by no such act of purpose can you control the action of poisons, the swelling of the thyroid, or the congestion of the neurolgia. Again, the mechanical theories do not square with the facts. Sleep, whatever else it may be, is in part a voluntary act. Certain *conditions* to be sure must be met, or at least they favor the process. We sleep more easily and quickly if we lie down in a quiet room, in the dark, after a warm bath, not having had more than two cups of coffee or more than one strong cigar. Many of us have an elaborate ceremonial which must be gone through with before we can fall asleep; we must make sure the door is locked and the window open, must say our prayers, lie for a few moments on the back, then turn upon one or the other side, or perhaps with the face away from or toward the wall, adjust the pillow to a specified height, and assume a particular bodily posture. We can delay sleep until this ceremonial or ritual is completed, and once it is finished we can sleep, unless we decide not to.

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[1] Taken from *The Psychology of Thought*, pp. 34–41. New York: D. Appleton & Co., 1926.

Further, the natural sleeper can always be awakened, and this is an important fact. Immediately after having been overcome by the poisons, the congestions, and the anaemia of the mechanical theories, he can be awakened and at once proceed to carry out a long and arduous task and remain awake for hours thereafter. Such a state is far from resembling the stupor of poisons or the profound inertness of the epileptic seizure. The mechanical and physiological theories again fail.

So far as the circulation theories are concerned, relating to the congestion of anaemia of the brain, the most careful work shows that the changes in circulation lag behind the mental process; that is to say, the person loses consciousness before delicate instruments attached to the brain reveal any changes in circulation. Further, the person is awake and conscious before the observable circulation changes begin to occur. Apparently these mechanical changes are not the cause of sleep, but only some of the effects.

A most important observation is that the sleeper before passing into the stupor can determine that a certain stimulus, and that only, among ordinary stimuli, shall awaken him. And the selected stimulus becomes endowed with this power. The sleeping mother, slumbering profoundly among numerous irrelevant noises, is quickly aroused by the feeblest moan from the cradle in an adjoining room. The telegraph operator sleeps through the din of his instruments until that particular combination appears which represents his own call or signal. At once he is alert. It thus appears possible so to establish a particular pattern in the brain that this particular pattern alone may remain awake and attentive, responsive to its appropriate stimulus. Such control presents a formidable difficulty to any physiological or, at least, to any mechanical explanation.

A further point bears in somewhat the opposite direction. It is, namely, that all these facts just cited are true only within or up to certain limits. The resolution to awaken at a predetermined faint signal cannot be infallibly relied on. It is surer and safer to rely on a more intense or a more persistent stimulus—an alarm clock or a faithful friend. Sometimes the sleep is so profound that a variety of stimuli, all added together, are required to get the sleeper out of bed; one stimulus alone may disturb him but fail to bring him fully to consciousness. And as for the ability to postpone sleep beyond the usual bedtime, and to shorten the sleep period, this if persisted in to a sufficient degree will mean discomfort and grave danger to the individual concerned.

A favorite mode of medieval torture took the form of keeping the prisoner awake for extended periods of time. Two investigators remained awake, for experimental purposes, for a period of ninety hours, nearly four days. By the end of this time they began to show loss of motor power, enfeeblement of memory, sluggishness of reaction, and they experienced vivid and distressing hallucinations, especially in the field of sight. However, when they did sleep, they report that 16 per cent to 35 per cent of the time lost from sleep was sufficient to restore them to their normal condition. Similar results are reported by other experimental observers. The same amount of lost sleep in the case of puppies is said to be fatal. But the data on the sleep of animals are not very reliable.

SLEEP AS AN ORGANIC RESPONSE

In general, then, we cannot adequately conceive sleep to be a condition mechanically or physiologically imposed upon the nervous system through the agency of pressures, poisons, and the like. Sleep is a response of the individual; it is an act *mediated by* the nervous system rather than a state imposed upon it. Normal sleep shows so many differences from the states of stupor and insensibility induced by anaesthetics, narcotics, and other drugs, that the resemblances between the two conditions must be regarded as more or less superficial.

Sleep, it would seem then, is a response to a stimulus, the nervous system being at one and the same time the medium through which the adjustment is effected and also the effector which is adjusted. This presumably means that one portion of this system is thrown into its characteristic adjustment through the mediation of another portion of the system. It is not usual to speak of the nervous system as an effector mechanism, however, and to this fact is due, in some measure, the current mystery of sleep.

The fact that sleep seems to be a native response in the case of newly born infants is no argument for its biological inevitability. The grasping reflex, for example, is also present in infants, but in a few months it has disappeared, or at least given place to other forms of manipulation. It seems most intelligible to suppose not that this reflex "disappears" because of any inner law of its being; instead it is presumably stamped out or modified on the grounds of its practical futility or its occasional positive dangerousness. Except for the futility and the danger, we might expect the grasping reflex not only to remain as a permanent feature, common to all individuals, but to become strengthened, and to compel the organization of other manipulations around itself. The reflex would then be looked upon, no doubt, as a biological necessity of the organism.

The grasping reflex, which we have just considered, is commonly described as a vestigial adjustment, which disappears because of its inutility. It seems far from absurd to conceive the sleep reaction of the newborn infant as a similar vestigial adjustment, philogenetically serving for the protection of the helpless individual. In the case of human infants, at least, it is easy to see how this useless vestige comes to serve a new purpose; it is fortunate for the parents, nurse, and companions of the infant that he does occasionally fall into a stupor. This enables them to relax their vigilance and to go about their own affairs with at least a reasonable degree of continuity. Adults thus not only welcome the vestigial stupor of their offspring, but encourage it in various ways and, under medical advice, do their best to perpetuate it. Very quickly the whole physiological economy of the growing organism adapts itself to this imposed rhythm, just as the metabolism of the drug addict adapts itself to his poison, and the sleep habit becomes fixed. In time it does not even require the original stimulus, whatever that may have been, but through the reintegrative mechanism becomes induced through a great variety of stimuli, such as approach of darkness, ringing of the curfew, being laid on the back, donning sleeping apparel, being rocked by the caretaker, or being pointed at by an impressive physician, who then calls himself a hypnotist.

What the "original" stimulus to sleep reactions may have been is, in the present state of our knowledge, largely a conjecture. It is not clear, for one thing, what that stimulus is in the case of the newborn child. Nor is it clear that, whatever this stimulus may be, it is identical with the primary sleep stimulus in the philogenetic history of the race. We do know that sleep may now be brought about by a great variety of stimuli or situations, which have, through the process of substitution, become connected with it. It is, moreover, important to note that what are ordinarily indicated as the immediate stimuli or justifications of sleep are usually instead actually its premonitory symptoms. That is to say, the difficulties of attention, loss of interest, forgetfulness, absent-mindedness, incoordination, and apathy, which are often said to "bring on" sleep, are instead the result of sleep, the signs of its beginning. The usual accounts are much like saying that the motion of a body is caused by its starting to move, or that an automobile accident was caused by the collision which constituted it, or that the heating of an object is produced by its rising temperature.

Our final point with respect to the satisfactoriness of the sleep theories concerns the mental experiences that we undergo as we fall asleep and as we awaken. We do not suddenly pass from alertness into stupor, nor from somnolence into the full waking state. Between the waking state and the sleep state there is an intermediate condition, the state of drowsiness, which deserves special attention. In passing from the waking state into sleep this condition is usually more conspicuous than in the process of awakening, although it is present in both cases. During a period which, depending on the individual, and on the circumstances of the occasion, ranges from a few minutes to a quarter- or a half-hour in length, curious changes in mental state are to be observed. (See chapter xiv, section 5.)

EXERCISES

1. To what extent do the foregoing theories contradict one another?
2. How many of them, and which, could consistently be held at once?

3. THE DEPTH OF SLEEP[1]

BY WILLIAM H. HOWELL

The intensity of sleep—that is, the depth of unconsciousness—has been studied by the simple device of ascertaining the intensity of the sensory stimulus necessary to awaken the sleeper. Kohlschütter used for this purpose a pendulum falling against a sounding plate. At intervals of a half-hour during the period of sleep the auditory stimuli thus produced were increased in intensity until waking was caused. His results are expressed in the curve shown in Fig. 106, in which the intensity of the sleep is represented by the height of the ordinates. According to this curve, the greatest intensity is reached about an hour after the beginning, and from the second to the third hour onward the depth of sleep is very slight; the activities of the brain lie just below the threshold of consciousness. It appears also from this curve that the recuperative effect of sleep is not proportional to its intensity. The long period from the third to the eighth hour, in which the depth of sleep is so slight is presumably as important in restoring the brain to its normal waking irritability as the deeper period up to the third hour. That this is the case is perhaps sufficiently demonstrated by the experience of every one, but Weygandt has attempted to prove the point by direct experiments. He found that for simple mental acts, such as the addition of pairs of figures, a short sleep was as effective as a longer one, but for more difficult mental work, such as memorizing

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[1] Taken from *A Text Book of Psychology* (7th ed.), pp. 259–61. Philadelphia: W. B. Saunders Co., 1918.

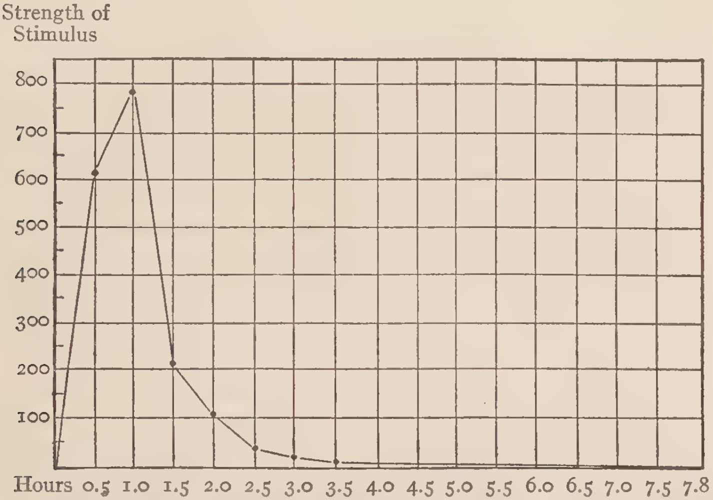

FIG. 106.—Curve illustrating the strength of an auditory stimulus (a ball falling from a height) necessary to awaken a sleeping person. The hours marked below. The tests were made at half-hour intervals. The curve indicates that the distance through which it was necessary to drop the ball increased during the first hour, and then diminished, at first very rapidly, then slowly. (Kohlschütter.)

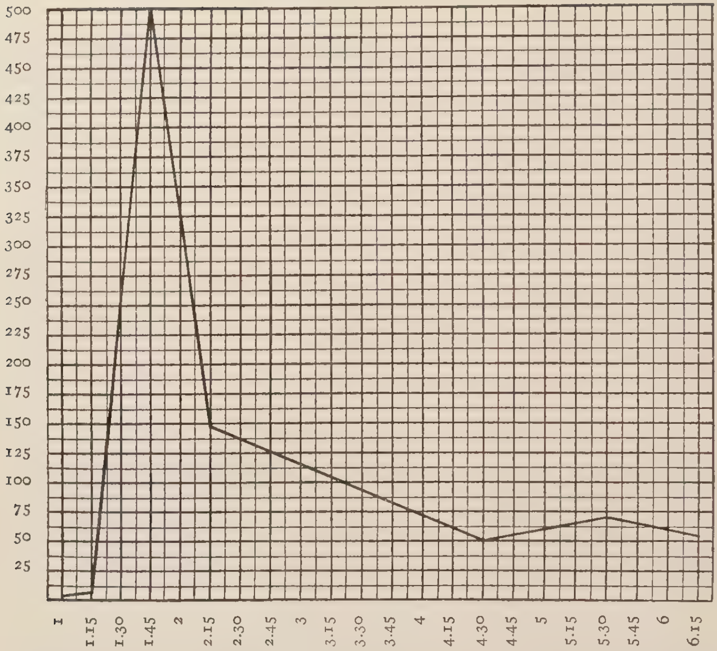

FIG. 107.—Curve of intensity of sleep according to Mönninghoff and Piesbergen. The figures along the abscissa represent time in hours from the beginning of sleep; those along the ordinate the relative intensity of sleep measured in milligram-millimeters, expressing the intensity of sound of a falling body necessary to awaken the sleeper.

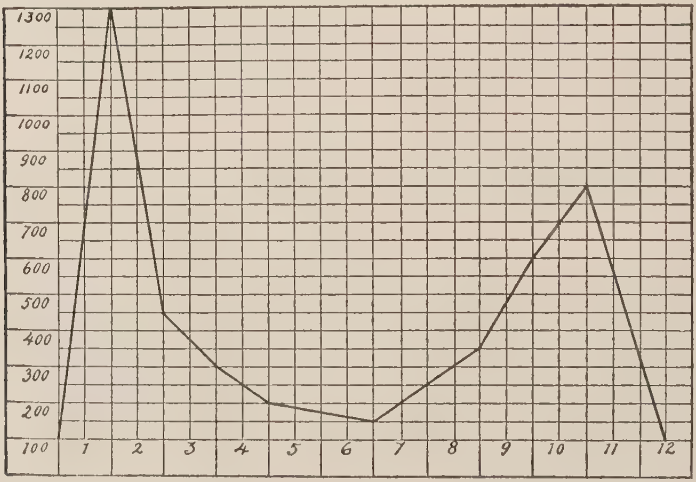

FIG. 108.—Curve of intensity of sleep in a child of three years and eight months, as determined by Czerny.

groups of ten figures, efficiency was distinctly improved in proportion to the length of sleep. It is probable that the curve of intensity of sleep varies somewhat with the individual and also with surrounding conditions. That individual variations occur is indicated by the results obtained by two other observers, Mönninghoff and Piesbergen, who used the same general method as was employed by Kohlschütter. The sleeper was awakened by auditory stimuli produced by dropping a lead ball from varying heights upon a lead plate. Only two experiments were made each night, and the curves constructed represent, therefore, composites from several periods of sleep. One of the curves obtained is represented in Fig. 107. According to this curve the maximum intensity is reached betwen the first and second hours, and between the fourth and the fifth hour there is a second slight increase in intensity, giving a second maximum in the curve. This latter feature of a second increase in intensity toward morning is very apparent also in some interesting curves obtained by Czerny from children of different ages. His method of awakening the sleeper was to use induction shocks of varying intensities. In children of four years with a normal period of sleep of about twelve hours the curve shows a very marked increase in intensity toward morning, as shown in Fig. 108. Curves made by similar experimental methods are reported by Howell and by Michelson. The striking feature about all the curves is the sharp increase in intensity shortly after falling asleep; in most cases the maximum is reached at the first or second hour of slumber, but Michelson believes that there are two classes of individuals in this respect, those with morning dispositions in whom the maximum of mental efficiency occurs early in the day and who upon going to sleep show a maximum of intensity within an hour, and those with evening dispositions whose maximum efficiency comes later in the day and whose curve of sleep reaches its maximum of intensity with relative slowness ($1\frac{3}{4}$ to $3\frac{1}{2}$ hrs.).

EXERCISES

1. What is suggested by the foregoing experiments in regard to the possible efficacy of a short daytime nap?
2. How would you explain the second deeper sleep which Czerny found toward morning?

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